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Efficiency in Production of Automobile Cylinders

The Refinements of Molding and Casting Operations Practiced at a Modern Plant Are Discussed, With Details of the Methods of Gating

"NOTHING succeeds like success," is an old saw which can be applied to the automobile cylinder foundry business equally as well as to the gasoline industry fostered by the oil barons. Since the advent of the motor car, foundry practice, particularly light work, has been revolutionized and castings of such intricate design are being made successfully today, which were considered impossible of production 15 years ago. No branch of casting manufacture has been as inviting to the foundryman as that afforded by the automobile and motor truck cylinder, nor is any class of work surrounded with more pitfalls which have

FIG. 1—ONE OF THE CYLINDER MOLDING FLOORS OF THE ALLYNE-RYAN PLANT, SHOWING THE TWO LARGE CUPOLAS WHICH MELT 110 TONS OF IRON DAILY

FIG. 2—A FLOOR OF SIX-CYLINDER MOLDS, SHOWING THE MOLDING MACHINE AT THE LEFT

proved the undoing of many who have ventured into this difficult and exacting line of endeavor. To the designer of motor cars, nothing, apparently, is impossible of accomplishment in the foundry, and this has resulted in intricate models and reduced thicknesses of wall section that involve the greatest refinements of the founder's art. The demand for lighter cars has forced a reduction in the weight of the power plant and every casting entering into the construction of the engine has been pared to its lowest allowable thickness. Therefore, it is not surprising that this work has developed into a specialty and many shops have been built and equipped to produce these castings exclusively.

On many jobs, cylinder foundrymen refuse to quote on the pound basis, fixing a price for the casting that will be commensurate with the work involved and the high losses sustained. Reduced to the pound basis, the prices paid for certain types of cylinder castings are enormous, yet from the standpoint of the foundryman they no more than cover the risk of doing this class of work. Losses of 40 per cent, in some shops, are not at all unusual, to which must be added the rejections by the buyer.

Less than four years ago the plant of the Allyne-Ryan Foundry Co. was established in Cleveland for the purpose of specializing in motor car castings. The foundry was designed and equipped solely for this class of work and some of its remarkable achievements were described in THE FOUNDRY, July, 1913. Since the publication of this article, the plant has been greatly increased in size and the melting capacity has been more than doubled. Another cupola, 102 inches in diameter, has been installed, and the equipment has been

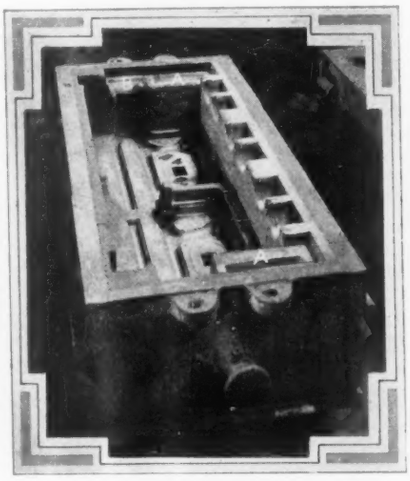


FIG. 3—DRAG HALF OF HUDSON SIX-CYLINDER MOLD SHOWING METHOD OF GATING

added to, to keep pace with the growth of the melt. The improvement in practice likewise has made similar progress and the methods pursued permit of maintaining an average loss of only 8 per cent. A bonus of 10 per cent of their salaries is paid to the shop executives for keeping the average losses down to 8 per cent or less, and not a month has passed in which these bonuses were not paid.

In mastering the difficulties of automobile cylinder work, many problems had to be solved and the wonderful success attained by this plant is attributed to the painstaking attention given to every detail of the operations. For practically every job special rigging is provided, making it impossible for the coremakers and molders to go wrong. Molding machines also play a conspicuous part in the success of this shop, a total of 107 being in use in the foundry and the core department, including the Adams, Berkshire, International, Osborn and Pridmore types. Coupled with the proper rigging and equipment is system, every operation apparently being timed to eliminate delays and lost effort. The melt from two cupolas, 78 and 102 inches in diameter, respectively, now overages 110 tons daily, of which approximately 40 per cent is return scrap in the form of gates, runners and risers. Semi-steel mixtures are employed for all of the castings, varying from 8 to 12 per cent steel content.

In these days of labor unrest, the wages earned by the molders in this shop, on the piecework basis, will prove a revelation to most foundrymen. Operating molding machines in gangs, consisting of four or five molders and two helpers, the molders are able to earn from $135 to $154 in a 12-day working period. It is doubtful if these figures even can be approached in any casting

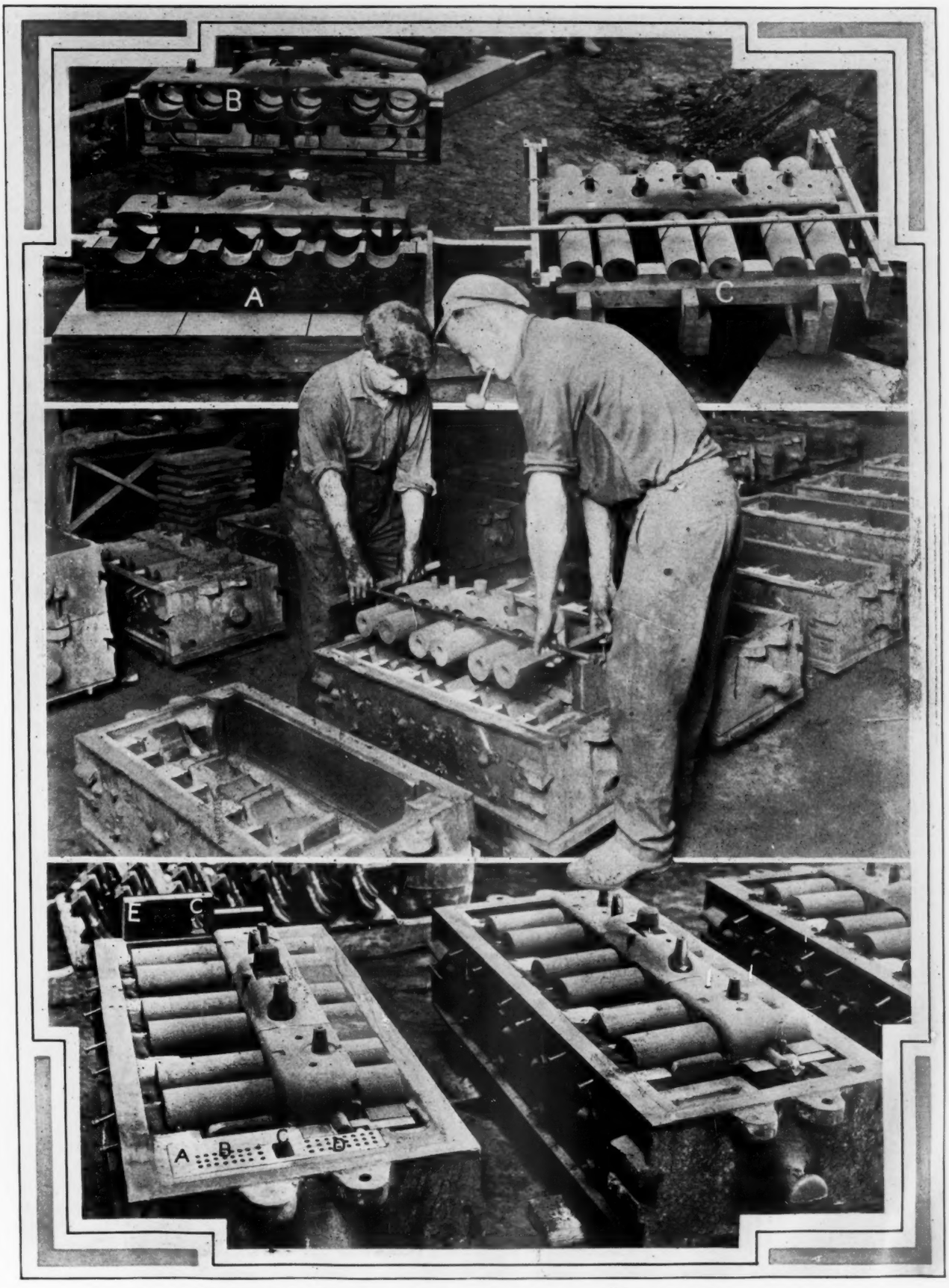


FIG. 4—ASSEMBLED CORES FOR SIX-CYLINDER MOLD WITH CORE FRAME AT THE RIGHT
FIG. 5—MOLDERS LOWERING ASSEMBLED SIX-CYLINDER CORES INTO A MOLD
FIG. 6—SKIM GATES USED IN THE SIX-CYLINDER MOLD

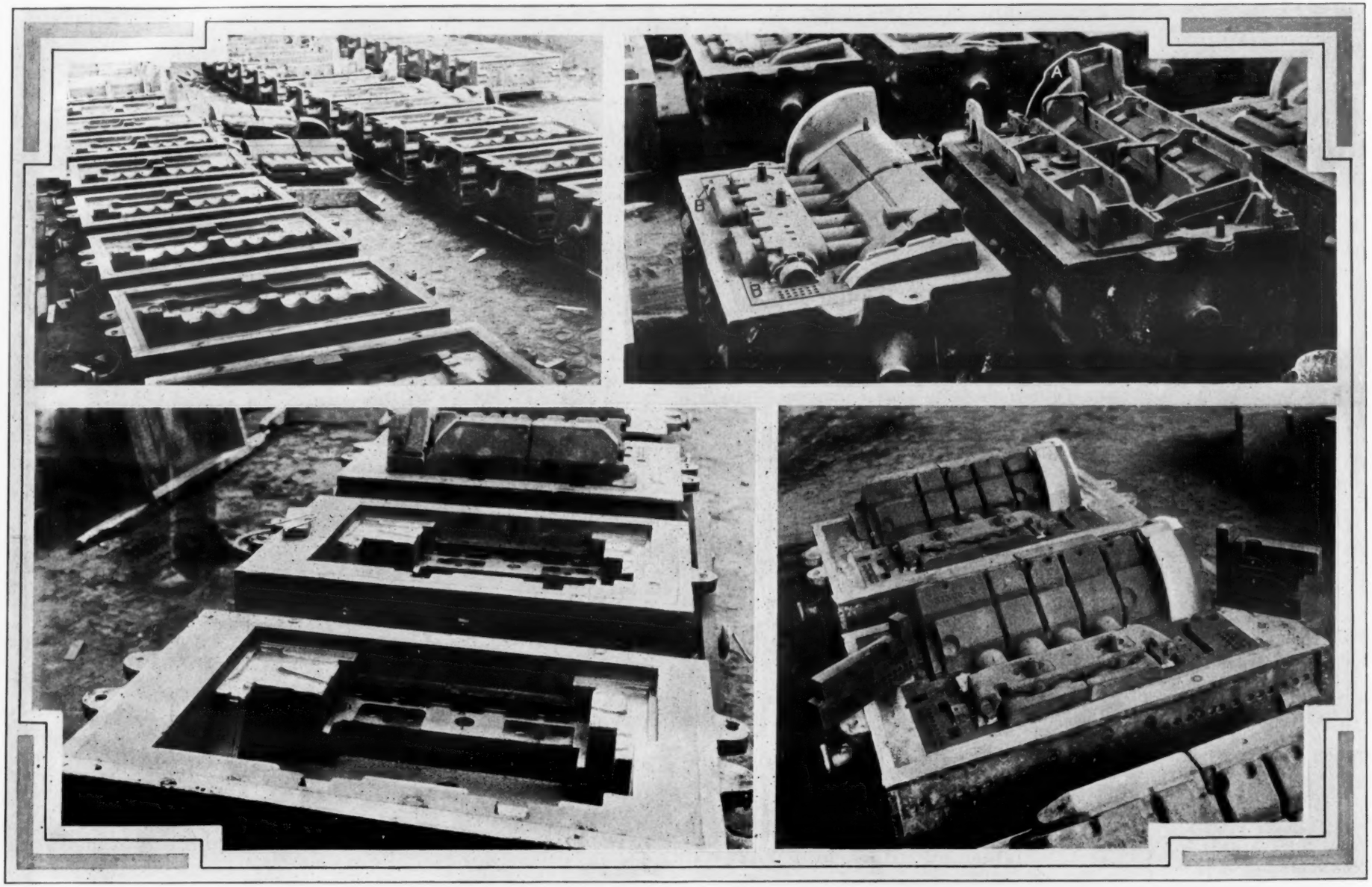


FIG. 7—DRAG HALVES OF ANOTHER TYPE OF SIX-CYLINDER MOLDS, SHOWING THE METHOD OF GATING

FIG. 8—SKIM GATES IN THE SIX-CYLINDER MOLD, FIG. 7, AND GAGE TO TRY THE ACCURATE SETTING OF THE CORES

FIG. 9—HOW THE DRAG HALVES OF AN EIGHT-CYLINDER CASTING MADE FOUR *EN BLOC*, ARE GATED

FIG. 10—SKIM GATES USED IN THE MOLDS, FIG. 9

plant and they reflect the ingenuity of the management in furnishing the proper equipment, rather than the extraordinary ability of the individual operator. When the piecework price originally was established, the output per floor did not measure up to the totals of today, but notwithstanding the improved facilities afforded and the labor-saving equipment installed, making the bigger output possible, the rate has never been changed. The machine operators never work in excess of nine hours per day and frequently their floors are up in eight hours. The gangs engaged on cylinder work make the molds only, not being required to cut-over and temper the sand, pour-off or shake-out. Their output, therefore, is much larger than if they were compelled to perform the other operations customarily considered a part of the molder's duties. Even the work of the pouring gangs has been specialized, one gang carrying the iron to the molds while the other gang pours off. This arrangement has proved exceedingly satisfactory, since the men who constantly are engaged in pouring-off, became more proficient than if they were compelled to perform several operations.

The molders report for work at about 5 o'clock in the morning, and invariably ring out between 2.30 and 3:15 p. m., practically 30 minutes of this period being required for washing up. As far as possible, the large jar-ramming, roll-over, pattern-drawing molding machines are operated in pairs, the drag halves of the molds first being made, followed by the copes. Two molding gangs, operating on one type of cylinder castings, with the aid of a pair of molding machines can put up from 70 to 75 molds daily. Molding by hand, one cylinder mold is considered a day's work for one man. A force of 12 to 13 men constitutes one of these double gangs of which four are laborers, and the output per molder by the use of machines and the system in vogue, has been increased eight-fold. The first iron is tapped at about 10:30 a. m. and melting continues until 5:30 p. m. when bottom is dropped. After the molders leave their floors the castings are shaken-out by a separate gang and at night the sand is tempered and cut-over, two machines furnished by the Sand Mixing Machine Co., New York, being employed for this purpose.

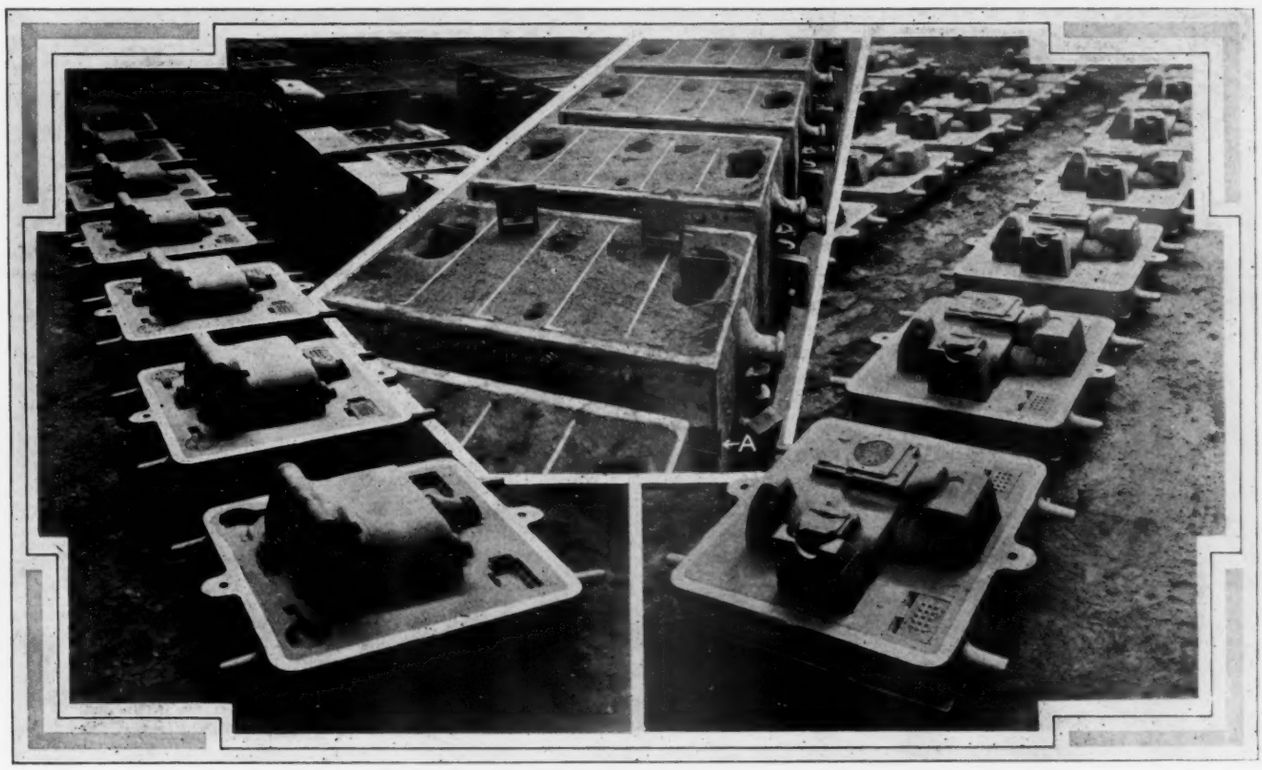


FIG. 12—SKIM GATES USED IN THE POURING BASINS

FIG. 11—SKIM GATES FOR TRANSMISSION CASE MOLDS. TWO OF THESE ARE ROUND AND TWO RECTANGULAR

FIG. 13—THREE SKIM GATES IN ANOTHER TRANSMISSION CASE MOLD

Extensive Use of Skim Gates

One of the features of the practice of this shop is the great care exercised to get clean iron into the molds. Skim gates, in the form of dry sand cores, are used not only at the entrances to the runners, but also in the pouring basins. In many of the molds, double skim gates, in addition to the skimming of the metal in the pouring basin, are the precautions resorted to for the purpose of producing clean castings. All of the cylinders are molded in green sand, although the tendency recently, owing to the reduced thickness of the wall section of these castings, has been toward the use of dry sand molds, many shops having resumed this practice, after a trial with green sand molding.

One of the most intricate parts designed by the automobile engineers to satisfy the high speed craze, is the six-cylinder casting, for the Hudson motor car. It involves an unusually large amount of core work and many of the foundrymen who have tried this job have found it to be very difficult to run. Proper gating was the problem that had to be solved, and after considerable experimenting, these castings are being made successfully in the Allyne-Ryan shop. Here again the proper mounting of the pattern and adequate rigging was a big factor in the success of the work, $3,000 having been expended before the pattern was put into the sand.

The drag half of the Hudson six-cylinder mold is shown in Fig. 3, with only one L-shaped core in position. The metal enters the mold at either end through skim gates placed over *A*, these two depressions forming reservoirs, and when it rises above the top of the end sand wall it passes over skim

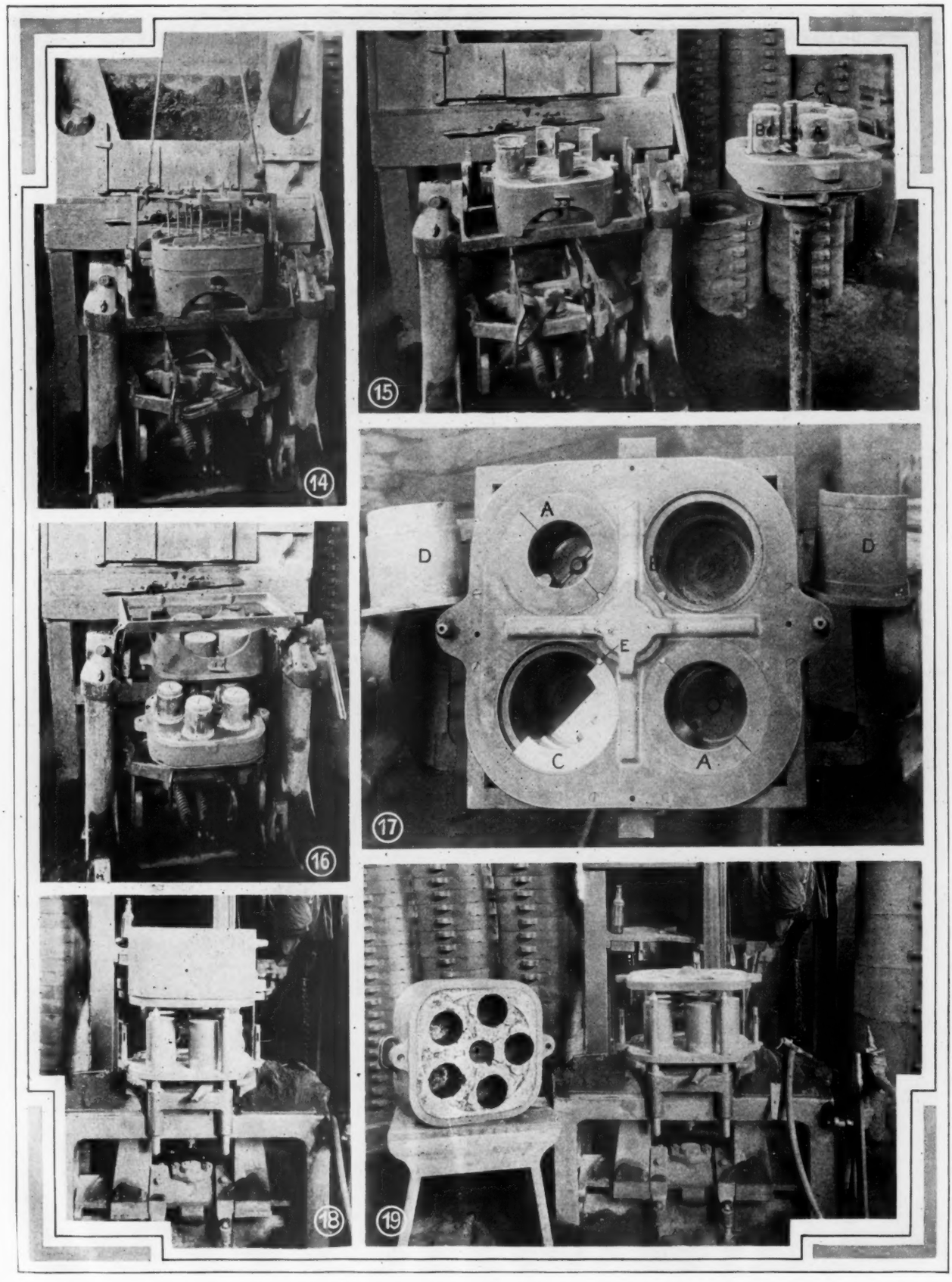


FIG. 14—VENTING DEVICE FOR GREEN SAND PISTON CORES; FIG. 15—PISTON MOLDING MACHINE WITH DRAG ON THE STAND AT THE RIGHT; FIG. 16—DRAG PISTON MOLD LOWERED AWAY FROM THE PATTERN; FIG. 17—PISTON PATTERN PLATE SHOWING THE SHELLS FOR THE GREEN SAND CORES; FIG. 18—COPE MACHINE FOR PISTONS WITH MOLD STRIPPED AWAY FROM THE PATTERNS; FIG. 19—COPE LIFTED OFF AND READY TO CLOSE OVER THE DRAG

gates again before entering the runner leading to the gates in the mold. In addition to the gates, clearly shown, four horn gates help to distribute the metal. Fig. 6 clearly illustrates the skim gates, this view showing several drags with the cores in position. The metal strikes the sand at *A*, flows through the openings *B*, into the basin, *A*, Fig. 3. When this basin is filled the metal flows out of the opening *C*, Fig. 6, and over the openings in section *D* of the skim gate. From this gate it passes through *B*, Fig. 3, into the mold.

FIG. 20—CORE BENCH ON WHICH SIX-CYLINDER CORES ARE ASSEMBLED

One of the skim gate cores, ready to be placed in the mold, is shown at *E*, Fig. 6. The opening *C*, through which the metal rises to pass through the openings in section *D* is made in the dry sand core constituting the skim gate. The use of skim gates is the pouring basins of cylinder molds is illustrated in Fig. 12. In the two molds in the foreground the gates have been placed in position, the metal being poured into the basins at one side, flowing through the openings in the gates, thereby preventing slag from entering the molds with the metal. Front and reverse sides of two of the skim gates, which are dry sand cores, are shown on top of one of the molds. One of the features of pouring the metal is the method of supporting one end of the ladle shank while the flow of the metal into the pouring basin is being regulated. At *A*, Fig. 12, is shown a dovetail at the end of the cast iron flask into which a supporting arm is inserted for holding the ladle shank. As the pouring gang passes from mold to mold, this arm is removed ready for insertion in the next flask. All of the cylinder mold flasks are equipped in this way, the men not only being relieved of the weight of the iron in the ladle, but it also insures the flow of a steady stream of metal into the mold. The pouring of cylinder molds by the use of bull ladles recently has been introduced and has proved successful. Two ladles are swung from a traveling crane on a chain divided by a separator, each ladle pouring iron into the pouring basins of the cylinder mold. The capacity of the two ladles is sufficient to cast 10 molds.

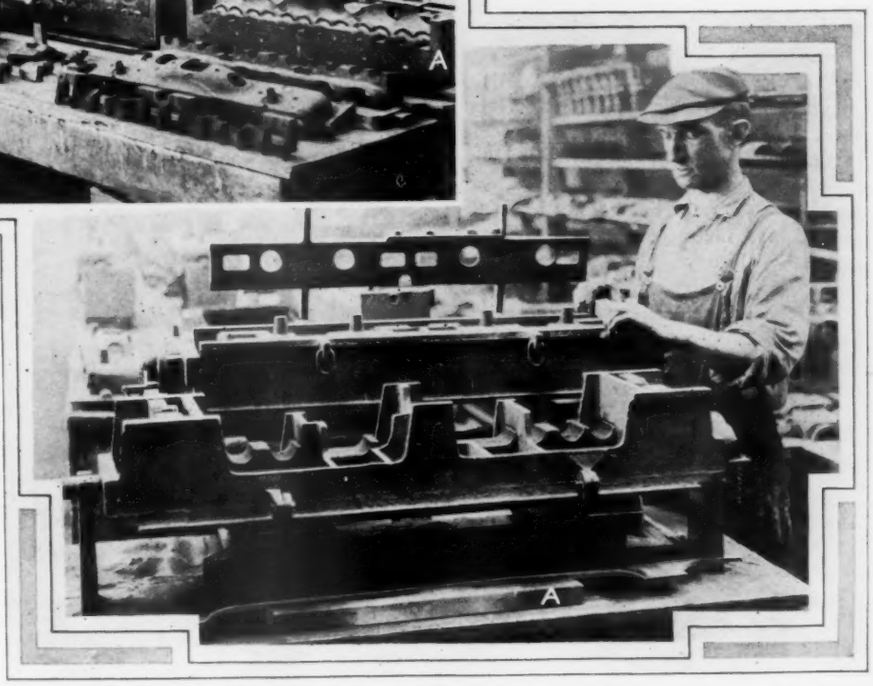


FIG. 21—ROLL-OVER FRAMES ON WHICH CORES ARE ACCURATELY MACHINED

The cores for all of the cylinder molds are assembled in the core department, where they are machined and pasted together ready for placing in the molds when delivered to the various floors. At *A*, Fig. 4, are shown the assembled cores for the Hudson six-cylinder casting on the carrier on which they are brought from the core shop. The only core work that is required of the molder is the insertion of the six barrel cores; *B* is a view of the other side of the assembled cores and shows the many intricate ports and passages; *C*, Fig. 4, is the frame in which the assembled cores are placed for the insertion of the barrel cores; it also permits of placing the wires around the barrel cores and adjusting the end supporting handles for carrying the core and lowering it into the mold. The six wires are bent into a half circle at one end and support the long projecting ends of the barrel cores. In Fig. 5, two molders are lowering one of the assembled cores into the mold. After the core is in position, the wires are released from the cross bar permitting the removal of the handles, while the wires are removed from the barrel cores by a slight turn. After the cores are in position and before the mold is closed with the cope, the cores are tried with a gage for metal thickness which does not exceed 5/32-inch in the water jackets. One of these metal gages, over the cores in another type of six-cylinder cold, is shown at *A*, Fig. 8. In addition to the bearing points on the machined parting line of the flask, the gage has bearings on the core prints, but elsewhere, openings the thickness of the metal must be provided between the core and the surface of the gage. The cores of every cylinder mold are gaged in this way, which is the last precautionary step taken to insure a uniform metal thickness in the castings. All of the gages are provided with handles and are skeleton frames to reduce their weight. Similar gages, as well as templets, are used in the core department, where the cores are assembled.

FIG. 22—A FLOOR OF CYLINDER MOLDS AT 11 A. M.

It was previously stated that the cylinder cores are machined, and that is the term which should be applied to the operations performed in obtaining true surfaces. Fig. 21 shows two jigs designed especially for machining cores for the Hudson six-cylinder casting. In the machine in the foreground is the base core after filing and rolling over in the frame. In the frame in the background are the center jacket and cap cores assembled with the operator filing the surfaces to get true bearings. After all of the surfaces have been machined, the cover is lowered and clamped, the frame rolled-over, and the operation repeated on the other side. Not only are true bearing surfaces obtained in this way, but the accurate assembling of these two parts of the cores is insured. One of the files used for this work is illustrated in the foreground at *A*.

After the cores have been machined they are stored on racks, illustrated in Fig. 20, to be assembled on tables, one of which is shown in the foreground. All of the cores are assembled in the machined base core, shown at *A*; *B*, *B*, *B*, *B*, are four of the Hudson six-cylinder cores assembled and on the table in the foreground are the numerous parts which are pasted together. Here are shown respectively, the cap, cope and center jacket cores, the intake and exhaust cores, small port cores, the yoke and the end cores. All of these parts are assembled and pasted together, and when the foundry is crowding the core department, the assembled cores are placed in an oven to effect the rapid drying of the paste. All of the cylinder cores are machined and assembled in this manner, requiring no further work on the part of the molder than the insertion of the barrel cores and lowering into the mold. Nearly 400 men are employed in the Allyne-Ryan core department and the size of the output is reflected by the core oil consumption which averages eight barrels daily, furnished by the Werner G. Smith Co., Cleveland.

One of the Cylinder Floors

A view of one section of the Hudson six-cylinder molding floor is illustrated in Fig. 2. The large, Osborn, jar-ramming, roll-over, pattern-drawing molding machine on which the copes and drags are made, is shown at the left. The molds are deposited on a buggy from which they are removed to the floor by the air hoist. In the center bay, the Osborn cylinder molding machines are served by four overhead, electric traveling cranes which are constantly engaged in removing molds from the buggies to the floors. It is the intention to operate this job with two molding machines with an output of 100 cylinder molds daily. A handy core rack is shown suspended from the wall in the background. Here the barrel and gate cores are neatly piled, convenient for use. In the foreground, at *A* and *B*, are two cast iron bottom boards which insure level bearings for the flasks and will not warp or burn-out; *B* is the reverse side of the board showing the four cored supports and the entire board is cored with numerous openings for lightening purposes. The progress of the cylinder molding work is well-illustrated in this view. The newly-made drags are in a row on the floor near the machines, and in the background, as well as the foreground of the row at the right, the cores have been placed and the copes have been closed-over a number of drags. Since the pouring of the molds commences at about 10:30 a. m. the molds are clamped ready for the pouring gangs, while the molding operations are carried on, the same as in a continuous foundry.

The method of gating the molds for the Northway, six-cylinder casting is illustrated in Fig. 7. It will be noted that the metal flows through three gates on one side and two on the other. The skim gates for this mold are shown at *B*, Fig. 8. The cylinder castings for the Olds "Eight" are cast in halves, four *en bloc*, the drag halves of two of these molds, illustrating the method of gating, being shown in Fig. 9. The metal enters the mold through three gates on one side and four on the other. The skim gates for these molds are shown

FIG. 23—THE WELL-EQUIPPED CLEANING ROOM

in Fig. 10. The gates are arranged with openings to permit the slag to rise and to prevent it from entering the mold with the metal.

As previously pointed out, skim gates are used in all the molds made in the shop, and Figs. 11 and 13 illustrate their employment in transmission case molds. In the foreground in Fig. 11, the gates in the drag half of the mold are clearly shown and in the remaining molds the skim gates have been placed in position. At the left are two round gates and the two gates at the right in each mold are rectangular. In the transmission gate molds, illustrated in Fig. 13, three skim gates are used, one circular and two rectangular.

A floor of molds for the Olds "Eight", cast four *en bloc*, is illustrated in Fig. 1, with the two cupolas in the background. At the side of the outside row of molds are shown three core carriers on each of which is placed all of the cores required for one mold. The metal is distributed throughout the shop by an electric trolley system, ladles being delivered to the most distant floor in one minute. Since all of the work is extremely thin, hot iron is essential. The fuel consumption, therefore, is heavy, and in spite of the big melt and the almost continuous operation, the melting ratio is never better than 1 to 4. This may seem an extravagant use of coke, but it has been figured that the loss of one cylinder casting, because of dull iron, more than compensates for the consumption of several tons of coke, and no chances are taken by experimenting with high melting ratios since hot iron is a known necessity. The small, air-cooled cylinder casting illustrated at the left and at the top of Fig. 1, is one of a large number made for aeroplane motors. The air-cooling fins are only 1/16-inch thick and the cleaned casting weighs only 9 pounds. These castings were poured in dry sand molds. Fig. 22 shows another floor of cylinder molds, the illustration representing the progress of the work to 11 a. m.

In the Allyne-Ryan foundry it formerly was the practice to make piston molds by the use of dry sand cores and this method is followed in many shops today. It was realized that the molding cost could be reduced considerably with green sand cores and special rigging and machines were devised to eliminate the use of dry sand cores. The machine on which the drags are made is shown in Fig. 14, with the special venting device partially withdrawn after venting the green sand cores. This venting equipment is an important feature of the piston molding outfit. This mold, as will be shown subsequently, contains five pistons and each core has two vents. Ten wires for venting the five cores are supported by a counterbalanced frame, and after the mold is rammed and the bottom-board placed, the venting frame is lowered until it contacts with the cast iron bottom board. The frame is lowered accurately by V-guides on both the frame and the machine. The wires are carefully adjusted to vent the cores to within ⅛-inch from the surface of the piston heads. The mold is rammed by hand.

After clamping, the mold is rolled over and lowered away for the pattern, as shown in Fig. 16, and is ready to be lifted off to be placed on the stand at the right of Fig. 15. Since the pistons contains bosses extending into the cores, it is impossible to draw the patterns straight and this difficulty has been overcome by the use of semi-circular shells which are withdrawn sideways by the molder after the drag of the piston mold has been placed on the stand. These shells are shown on top of the pattern in Fig. 15, and partially in place

FIG. 24—THE TESTING BENCHES ON WHICH THE CYLINDER CASTINGS ARE SUBJECTED TO 100 POUNDS WATER PRESSURE

and withdrawn from the mold on the stand. From the core at *A*, the shells have been removed, but only one-half of the shell has been withdrawn from the core *B*. At *C* two shells have been lifted away from the core, but are still in place on the mold. The top of the stand rotates to enable the molder to turn the mold for the removal of the shells without changing his position. Fig. 16 shows all of the shells in place on the green sand cores.

The drag half of a pattern plate containing four piston cores is illustrated in Fig. 17. At *A*, the semi-circular shells are in molding position in the mold, while from the opening, *B*, they have been withdrawn. At *C*, one of the semi-circular shells is in position and *D*, *D*, show the exterior outlines of two shells. Only one pattern plate is required for each machine, and by varying the inside diameters of the shells, pistons of any size within the range of the pattern plate can be made. Each size of piston, of course, requires a set of shells, but one pattern plate serves for all. Each pair of semi-circular shells is numbered from 1 to 4, or 1 to 5, to insure the fitting together of the shells for each core. The shells fit loosely in the pattern plate, remaining in position when the mold is lowered away from the pattern, and are prevented from rotating by the small lug, *E*. The pattern plate also clearly illustrates the method of gating. The copes are made on a jar-ramming, stripping plate, molding machine, shown in Figs. 18 and 19. After ramming, the stripping plate with the superimposed flask containing the mold, is stripped from the pattern by four posts and after lifting off the mold, the stripping plate is lowered to molding position on the pattern plate. On the bench at the left of Fig. 19 is shown the cope of the mold with a circular depression in the center which fits over the skim gate in the drag. With this equipment, which has been patented by the Allyne-Ryan Foundry Co., two men can produce 165 molds containing 825 pistons per day.

In a plant of this kind, the cleaning room presents many problems, since the inspection is unusually severe to curtail the subsequent rejections by the motor car builders. Practically all of the castings are cleaned on a piecework basis, many of the chippers earning from $65 to $75 for 12 days' pay. In this department, the same as in the foundry, the piecework price on a casting is never changed after it once has been fixed. A view of one section of the cleaning room is shown in Fig. 23. To keep pace with the large output of the foundry, cleaning operations are carried on night and day. The equipment is unusually complete, consisting of a large battery of exhaust tumbling mills, sand blast machines, swinging and stationary grinders, etc. All of the air lines are carried underneath the floor, connections being made through openings in floor plates conveniently distributed throughout the shop. All overhead piping is eliminated by this arrangement and greater flexibility of air service is obtained.

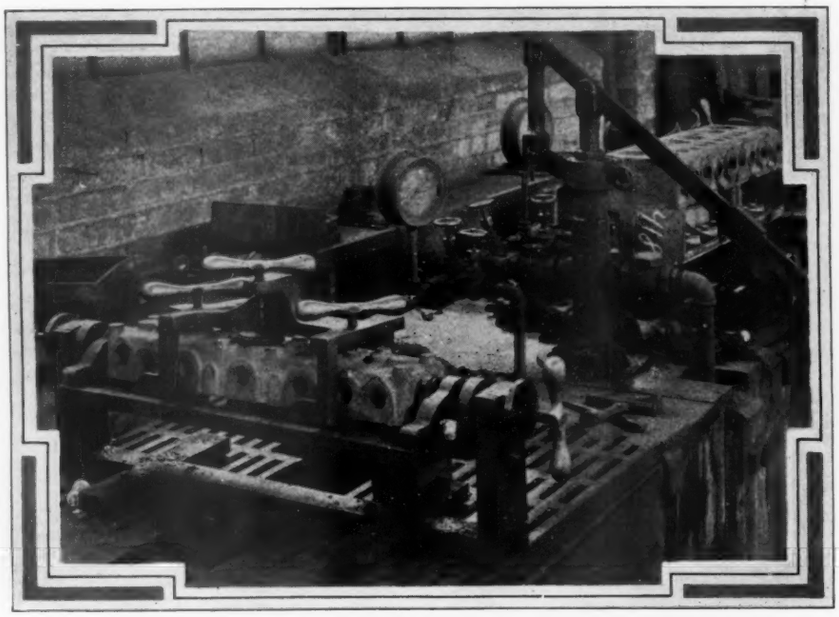


FIG. 25—A SPECIAL FRAME FOR RAPIDLY TESTING CYLINDER HEADS

All of the cylinders are subjected to 100 pounds water pressure to detect leaks and the battery of six testing benches is illustrated in Fig. 24. To facilitate this work, special frames have been built which require a minimum amount of adjustment for testing the water jackets. One of these frames is shown in Fig. 25. The casting undergoing the test is a cylinder head, the simplicity of the clamping being apparent. The frame is of the roll-over type which enables the operator to turn over the casting to inspect it for leaks.

To those not familiar with the automobile cylinder business, the extent of the industry will prove a revelation. With the annual automobile output approaching the million mark, orders for 25,000 to 50,000 cylinders are the rule, rather than the exception, and in spite of the large cylinder capacity of these specialty shops, the requirements are inadequate to the demand. Some motor car manufacturers insist upon the shipment of a carload of cylinders every day, while the needs of others are so great and immediate that they are compelled to resort to deliveries by express.

Annealing Gray Iron Castings

By W. J. Keep

Question:—What method and equipment are being used to anneal a light gray iron casting?

Answer:—The castings should be heated to a cherry red, at which point they should be held for several hours and then they may be permitted to cool off with the oven or furnace. Any kind of an oven or furnace in which this work can be done will answer the purpose. In any event, you should have an oven lined with fire brick and a fire box for heating purposes. You can utilize cast iron boxes, in which the castings are placed without packing, unless there is danger of warping, in which event they can be packed in burned molding sand, or, on the other hand, they can be packed with sawdust and the ashes can be used repeatedly. In urgent cases I have seen castings rolled into the oven on a steel wheelbarrow and left there over night, but this is not good practice, nor does it utilize the oven space to advantage. The castings can be piled loosely in the oven if you so desire. It will take several hours to heat the oven after it is filled with castings and several hours also will be required for cooling and this preferably is done by permitting the oven or furnace to cool off over night. If you place the castings into the oven as soon as they are shaken-out of the sand, the oven will be cool enough to remove the castings in 24 hours, when another batch can be charged.

The main office of Pettinos Bros., Bethlehem, Pa., is now located at 25 Church street, New York City.

Foundry Equations Expressed Without Numerals

Success in the Manufacture of Castings not Necessarily is Measured by Dollars and Cents, as Achievement is Greater Than Financial Profit

By Russell R Clarke

EQUATIONS are expressions of equalities of values. They consist of at least two parts or members, on either side of two short parallel lines, known to mathematics as the sign of equality. This sign indicates a balancing of values. It is the fulcrum of balance in the equilibrium of forces and means that the sum total of value on its one side is identical with that on the other. Thus, $5 + 2 + 3 = 7 + 4 - 1$, is an equation because the value is the same, numerically 10, in both instances. By way of applied illustration we might say that a man's strength + his skill + his speed + his knowledge + his effort + his endurance = his accomplishment, which would also constitute an equation.

Values are said to be equated when their equals are grouped and expressed. More broadly then, an equation is the grouping by principle of the separate parts of equals. In this sense a foundry equation is the grouping of definite foundry forces productive of definite foundry results. The former is a cause, the latter an effect, the one, an effort, the other its consequence.

We employ the principles of equation in the solution of problems and the derivation of unknown values. In detail of application these principles are manifold and interesting. However, they are subsidiary to one general principle dominating all others. Briefly stated, this general principle is that identical operations executed on all members of an equation alike do not affect the equality of the equation and means, that without impairing equality, we can do anything to one side of an equation provided we do the same thing to the other side also. Hitting rock bottom fact then, an equation represents a balance and will remain an equation only so long as balance is maintained.

This applies with equal force in the foundry. You cannot get along without it, for by the principles of equation, the moment you destroy balance, you have illogical conditions. It means you cannot increase the efficiency of your product without increasing the efficiency of its producing medium. You can't add to the inherent quality of your casting and not add to the quality of its constituency nor detract from the one without detracting from the other. You can't say copper, 92; tin, 6; lead, 1, and zinc, 1 equals copper, 88; tin, 10, and zinc, 2 and get away with it for an equation. You can't take something from nothing and have something left. You can't lose 6 per cent of your metal in manipulation and have 98 per cent of it in your gates and castings. You can't oxidize 5 per cent of that metal and have no oxide. You can't lose 40 per cent of your power in transmission and have 100 per cent of it in your machinery. You can't equate a 50,000-pound daily metal consumption by a 20,000 pound daily melting capacity. You can't tolerate a bad practice and expect a good result; you can't set a 40-cent man to a 20-cent task and realize a 20-cent cost. You can't raise the indicator of your business success and not apply more pressure. You can't do anything in a foundry and do it well except strictly on and by a balancing system.

Vague Notions of Foundry Equation

The world of business, men or other calling, have their own vague notions of a foundry equation. The world of foundrymen, men of practical foundry experience, have other and more valuable conceptions. In substance, the commercial idea is this: Raw material + a foundry = a casting. On this they may shade a little and say good material + a good foundry = a good casting, or poor material + a poor foundry = a poor casting; or they may generalize and say quality of material + quality of foundry = quality of casting; but that's about as far as they ever get. The foundryman's equations equal a more definite and searching conception.

If you are a successful foundryman you are in the business for the high purpose of making a success out of the business and if that's not the inspiration of your best effort you'd better get out of the business. Your foundry success depends largely on your good foundry reputation. If you do not have one, you had better get one.

I admire the successful man of any business. I admire a successful hobo. Not because he is a hobo, but rather a successful one. I think more of the man who puts something over on me that I do of the man who tries and falls down on the job. I may condemn the one for a rascal just as bitterly as I do the other, but just the same, I'll make a mental reservation that the first fellow is an *A-number-one* rascal. He aimed at a shining mark and hit it. He made a success of his business. Nothing succeeds like success.

You can be a successful foundryman, not so much because you like the business, but rather because you like the success of the business. Personally, I am not so much *stuck* on the business as I am stuck to the business. I like that master idea of John Ruskin who said: "You cannot serve two masters. You must serve either the one or the other. If your work is first with you and your fee second, then work is your master and the lord of work, who is God. But if your fee is first and your work second, then fee is your master, and the lord of fee, who is the devil". Successful foundrymen are following the beaten path and working for success. Success has been the mecca of every successful business pilgrimage that ever left footprints on the burning sands of time.

In the entity of things gained and beneficence realized, foundry success can never be equaled by values expressed in dollars and cents, but rather in the consciousness that in attaining its goal we have been one more to brush aside its difficulties and make more easy for others the pathways behind us. That we have been faithful and successful doers of hard things hitherto undone. Such is the status of all true success, for whether expounded from the pulpit or argued in the busy workshops of life, it is written in the canons of the universe that "Service is Success".

So much for success attained, but how shall we attain it? What is it? With what producing values does it balance? What does it equal? Here is our equation: *Foundry Success* = inspiration + information + determination + perspiration. Let us briefly note each in order.

Inspiration is a first great cause. It is an irresistible force. Do you know that the best books that ever have been written, the highest marks that have ever been set, the greatest feats that have ever been accomplished attest the irresistible mental and moral force of inspired men and women? Only a few weeks ago President Wilson came to your city and disclosed to a vast as-

From a paper presented before the Philadelphia Foundrymen's Association.

semblage of people, that no man who does not see visions will ever realize any high hopes or undertake any great enterprise. I like the dreamers of great things and grand attainments, for these are they who toil faithfully and win surely. Nor is their accomplishment unworthy of their faith and their effort. Purpose, enthusiasm, life itself is born of inspiration and you sadly need those things in your foundry. In the hard, up-grade of success, inspiration is your motive power. It is your own self-starter. Without it a man is an old-fashioned cranker and a crank. You don't want to be anything like that, so take an inspiring nap now and then and dream a few things, prepare and plan for them, only watch that you don't oversleep yourself.

He Didn't Know

I knew a Pittsburgh foundryman who scrapped a lot of valuable castings because of porosity and he made those same porous castings over and over again. He didn't know. He didn't know molten copper would absorb sulphur gas and liberate that gas in cooling. He didn't know not to try a carload of high sulphur coke. To make a success of the foundry business you have to know the business and to know the business as you ought to know it you have to exhaust every source of information tangent to the business. I pity the men who know it all and have nothing left to learn. They must be a lonesome bunch. On a printed page I never see the words copper, tin, lead, zinc, antimony, nickel, manganese, boron, silicon, phosphor, etc., but I read that page. I never sight the names Clamer, Brown, Dudley, Law, Sperry, Golden, Rafe, Gillette and a score of others, but I stop, look and listen. The things they know and have known I want to know. I need them in my business.

Years ago I was molding in a shop whose management bought a new and complicated molding machine recommended by the foreman. It made trouble right away. It wouldn't work right and men began to quit on account of it. I was given the job of assisting the foreman to get results from what looked like a bad bargain. The foreman was called away for a little while and during his absence I got disgusted with everything and fell in with the crowd of infidels around me. On his return the foreman came up to me, wearing a hopeful smile and asked me how was I doing? I had my answer ready and in giving it expressed the opinion that the machine was no good. Having thus voiced the general opinion of the shop, I looked up into the man's face and felt sorry. I don't think I ever saw a more pitiful look perch on the face of a mortal man. I thought of Caesar as he must have looked when Brutus stabbed him. But there were several historical differences. Unlike Caesar he didn't say "And you too, Brutus!" He didn't bury his face in a ruffled mantle; he didn't fall at the base of any statue; he didn't fall at all. He gave me a withering look and then drawing himself up to the full stature of his determination, he said: "That machine is all right. There's nothing wrong with it. I've bought it and it's got to go. Your job around here is to help make it go and if you can't do that I'll get somebody else who can." That's all he said. I said nothing. I was ashamed to look up again. I made up my mind to take another crack at the machine. I took a hard one and she went, went like a bat out of twilight. Lord, but how that machine did go, and she kept on going, she didn't dare stop and I had a wholesome respect for that man and that machine as long as it lived, for in the primer of "Get-there-philosophy" that machine was my object lesson, that man my worthy master. One hundred men said it wouldn't work. One man said "Its got to work" and it worked.

Determination

We lose everything when we lose faith. We win all things when we keep it. And when that faith is yours, then also is a mighty determination, a determination that sweeps opposition off its tottering feet and carries a man above and beyond the taunt and mockery of the rabble. You've got to use that spirit in your foundry diplomacy if you ever expect to win out. But don't think you are going to get away with and not sweat for it. It is not so nominated in the bond that such things can ever be. It is Edison, I think, who pronounces genius a little bit of inspiration and a whole lot of perspiration. The foundry business is like a close-mouthed criminal. There is a whole lot in him, but you'll have to sweat it out of him. Most men have a goodly stock of petrified ability packed away in their anatomy. The job is to loosen it up and get it out. You can't drive it out, you can't fool it out, you can't bribe it out, you can't coax it out, you can't even kick it out, but you can nearly always sweat it out. In the foundry business you run up against many hard difficulties, you know it and you know also that there is no foundry difficulty so utterly impervious to the action of any liquid that it will not dissolve in the salty brine of perspiration.

Foundry success = Inspiration + Information + Determination + Perspiration. That's one way of looking at it. There are others. We can equate it by other values. I'll state one. Here it is: "You can't be selfish in business. It might work in your home, at church, in society or on the street, but it won't go in business. You have a business right to hog for success. You have no business right to hog to yourself all its benefits. That gives us a basis for another equation: *Foundry success* = individual profit — trade benefit. No word is more familiar to the live manufacturer of the day than the word *efficiency*. It's a great word and a great idea. Like many other great affairs, however, it is sometimes misunderstood. I have never known of an organization permitting personal interest to dominate service that did not fail in the light of highest standards. I never knew a man to rise over the heads and shoulders of other men at the expense of service, to get up by pushing or knocking somebody else back, that he didn't sooner or later hit the earth with a thud. I grieve for the vanity of man and the world grieves with me. For I tell you this and it is truth that the misery, the hardship, the loss that it takes to make a personal record for a personal agent not qualified to that record, yet vainly aspiring to it, is cause for grief of many worlds. I resent no man being a bigger man than myself, but I do insist that he be a better one.

Efficiency is founded on principle and it's a good thing that it is, for efficiency very often refuses to admit what organization and management sometimes counsel. Efficiency is the sum total of the powers making for highest standard of results. It is the highest, most conservatively, powerful, definitely productive effort of efforts applying to the consequential order of doing things. It is strict logic observed in plan, execution, quality, quantity and consequence. We sometimes confound efficiency with competency. Efficiency is more than competency. It is competency on a larger basis of activity and elaborated with certainty of result at minimum of cost and effort. Foundry success equals every detail of foundry activity multiplied by efficiency. To state the equation more compresensively, we will say foundry success = man + matter + method, all multiplied by efficiency.

Two Ends of a Foundry

In a general way every foundry has two ends, a business end and a foundry end. Efficiency is equally important to each. You have a foundry, you have a market for its product. You own the foundry, you don't own the market. You don't even control it. It is an open market where you meet the brains and machinations of competition. The market is the acid test of your business ability. The foundry, of your foundry ability. There is no sympathy in a market. You know it. Men don't know each other there, they know only busi-

ness. You lose in the home, the farm, the factory, the foundry, somebody sympathizes with you. You lose in the market, somebody laughs at you. That's what they wanted to see. Go to the market to compete and you're like the man at bat in a baseball game. You're playing for yourself. Everybody else is playing against you and the better your batting average, the harder the other fellows play. In buying and selling alike, you need good business ability. You must strive for teamwork and keep good hitters at the plate. Foundry efficiency will produce a good casting, but it won't sell it. Business efficiency will sell a good casting, but it will not produce it. Consequently, neither is of much ultimate value unless equated by the other. I'll let that go for a self-evident truth and start now to equate foundry efficiency.

Foundry Efficiency Equated

My first proposition is foundry efficiency = utilization + conservation. Rather paradoxical that we can use things and still save them. The trouble often is we don't use them—we waste them. Waste is the great sin of the American people and an American foundry is notably American. In a foundry nothing is ultimately used that fails to show up in your output either product or by-product. Nothing is saved that detracts from that output in either quality, quantity or worth. The test of utility is not the usefulness of a thing, but its use. You may have a useful machine, some valuable space, a good man, some fair scrap material. Are you using them to the greatest advantage? If not, you are wasting them. You may have excellent means at your command. They are no good to you unless you use them. You may have mighty forces in your favor, to make them a power you will have to put them to work. American foundrymen have great economic questions before them. We are very wasteful, we still do foolish things. In foundry factors I called attention to the value of little things. Little things are molecules of great masses in conservation. They are the cents of foundry dollars. We can pick them up all around us.

At present we are mainly interested in three conservations. Conservation of time, energy and material. Again we can go to nature. Nature makes the most of everything. Nature never wastes anything. She has declared herself in inviolate law that she positively will not. If nature were to suddenly take over the running of our brass foundries, she would put us all to shame. Nature is great on little things. In practice what importance do you attach to little things? Do you make every gate yield its maximum quota of good castings? Do your molders obey principles in gating? Does every pound of metal melted, barring unavoidable loss, enter a mold or do you heel back to the furnace a chill or two with each pot? You say you recover that. No you don't, you recover only part of it. That loss in actual melting can't be recovered. You make new lips on pots as they wear away. Do you select the highest or the lowest points in the making? Do you save in charcoal and waste with oxide? You have foundry equipment. Do your men understand that if they wilfully or carelessly destroy that equipment they will have to pay for it? You use sand. Do men appreciate the difference between that sand and the dirt of the street? Do you get down to brass tacks and ashes in material conservation? If you don't there's something wrong with your efficiency system.

And as you faithfully conserve your material so must you also your energy. Every turn of every wheel, every trip of every hammer, every pulse of every engine, every ray of every light relies on high priced energy to produce it. It is highly essential then that this energy be not wasted, but used to the strict doing of necessary work. But of all energy demanding your most thoughtful conservation, human energy is the most important. Man power is the most expensive power on earth. It is also the most to be considered. Brain and brawn will tire while iron and steel and brass trip tirelessly on. Above all other, that's the energy you want to conserve.

The misuse of a thing is a great evil. Its disuse is sometimes a greater one. Degeneration and final extinction seem to be the ordained heritage of all things dormant or inactive. Exercise of function is absolutely essential to retention of ability and capacity.

Co-operation

Operation + Co. = Co-operation. You know what that means. You want the men to co-operate with you. Did it ever occur to you that now and then the man would be glad to have you co-operate with him? It's a poor co-operation that has only one benefit. Did you every see a foundry foreman hand a molder a stiff job, tell him to make it and walk away? Ever notice the puzzled look that develops on the molder's face as he looks the pattern over and tries to figure out the eternal fitness of intricate cores not definitely designated or some other casting or gating feature beyond his comprehension? Ever notice how quick the other workmen discover the puzzled man's dilemma and chuckle over the possible outcome, withholding any information they might possess in order to make that outcome the more possible? Ever know of a molder similarly situated to seek advice from a foreman on the job or some particular casting or gating feature? Ever hear a foreman thus approached to turn and say: "I hired you as a molder, not an apprentice?" Ever stop to think how much valuable time and high priced metal is jeopardized by the tolerated yet unwarranted spirit? Ever stop to consider the ultimate impression and result of that foreman's arrogance on his men? In the end it must of necessity result in disadvantage to the firm. Human nature, though it may for a season enjoy the manufactured hardships of a fellow workman, cannot enjoy it forever. In the last analysis, molders are intensely human. In their daily struggles they observe each others' hardships and troubles and ultimately sympathize each with each. Nor are they fools by any manner or means. They recognize a common foe and in secret and common, conspire against him. The result of it all is friction and dissatisfaction. Friction retards progress. Forces applied in opposition bring motion to a standstill. Man and management must work together else all will fall.

Foundry Efficiency = Originality + Imitation

There's a world of importance attached to that word *originality*. I am not quite sure that the general notion of its meaning is a correct one. We usually think of it as a talent or a gift and often associate it with genius. At any rate, a genius must be well stocked with originality. Now don't forget what Edison says about a genius for that's the basis of the thought into which I now purpose to lead you. Originality to my mind is synonymous with close application just as absolute non-inventitiveness is another word for do-lessness, or, if you like, laziness. Everything we do is a consequence of instinct, semi-instinct, which is habit, or intelligence. By intelligence we can't do anything without knowing something and learning something more. The more we think and do the more we learn and are able to do, the more independent and original we become. A lazy man will never possess much originality because he is too lazy to develop it. The products of application then are the visible manifestations of what we call originality.

Application is the source of your foundry originality. Originality is your foundry individuality. A man comes into your foundry and finds nothing out of the ordinary in general or detail of foundry status. You ought to be ashamed of yourself. You go into that man's foundry and note the same identical conditions. He ought to be

ashamed of himself and the both of you will be ashamed of yourselves when, as you surely will, tumble to it sooner or later that the world has little or no interest in anything that does not show more or less individuality.

The composite individuality of your foundry is largely commensurate with the interest you manifest in the creative tendency of your workmen and the encouragement you accord them in exercising it. For above and beyond the accomplishment of single effort is the power and capacity of united effort. There are just as bright men working at the bench as there are sitting at the desk. You need the valuable observations and suggestions those practical men derive from their daily experience and if you encourage them, they will give them to you. A pig-headed foreman is the greatest evil that foundry dust ever lighted on. I mean the fellow who, right or wrong, insists on having things done his way simply because he's boss. I am not ashamed to withdraw my plan in favor of a better one, regardless of the source of the better, and I should deem myself a criminal against all parties concerned if in order to satiate my own pig-headed instinct I follow out any other course.

Originate and Imitate

We must originate and we must imitate. I am not yet ready to believe that the generous giver of all things divided brains equally between any one man and all the rest of mortality. To be more explicit, I don't think any one man owns 51 per cent of the stock. I never talked to a live foundryman yet from whom I didn't learn something. I never expect to. We must imitate; however, in our imitating, we must strive not to fall down on the possibilities of imitation. This is often done. It occurs, not so much from misconception of the idea, but rather in failure to elaborate on the idea. The absorption and adoption of one man's idea by another should represent not its copy but its evolution. That is logical imitation and the only kind of imitation that is logical.

That word science has been woefully abused. It is derived from the Latin word *Scio*, meaning I know. I know, in the most definite, all embracing, concise, classified way. I know—I don't think—I don't guess—I don't suppose. I know, I know by principle, unfailing and absolute. That is scientific knowledge.

In its application to productive efficiency, science has a two-fold mission arising from a two-fold need. In all production we have to deal first with matter and second, method. That is, in our knowing we must know the nature of the thing we are working with and how to work with it to greatest advantage. In short—what to do and how to do it. We can know a thing in a practical way and we can do a thing in a practical way. We can also know and do it in a scientific way. In practice we observe rules. In science we are dominated by principle. A rule of practice may be a good thing, but a principal of science is a higher and a better one.

Student of Natural Order

Now whatever you do, don't let the dignity of that word scientific scare you away from its idea. Don't think that the efficiency expert or man of scientific management has something up his sleeve you can never comprehend. The efficiency expert is an expert on general principles and the art of applying them to particular cases. I take the efficiency expert seriously. I also take him logically. What I want to know is this, where did he get his principles? Can I go to the same source and get them also? I am willing to dig for them. Can I have them for the digging? I can, you can also. Consciously or unconsciously the efficiency expert is a great student of natural order. He got his principles from nature. Didn't Edison long ago tell the aerial craftmen that until they imitated bird principle they would never be able to fly like a bird and aren't they coming to it?

It cannot be too often repeated that the natural way of doing a thing is the scientific way. But you must divorce the idea of nature from that of habit. Man is the only animal that permits of its tasks in the hardest possible way. Intelligence has been our curse. It must also be our salvation. It must equate its evil with its good. Intelligence has wandered far from the simple, scientific order of nature and intelligence, appalled by the difference, overwhelmed by the simplicity of natural order; it is going back to natural order and labeling its effort scientific dogma.

And when in our brass foundries we have learned the inherent qualities with which nature has endowed our metals and the very nature she has imparted to them, when we have established by scientific and conclusive evidence the principles by which their effects on and affinities for each other are controlled and have come to an operative understanding of the simple and natural method by which they most advantageously combine, we will then be efficient metal men, scientific metal men, highest type of practical metal men.

I have but a single equation left to consider. It is an equation of all time and all conditions. Several years ago a man came to our shop and hired as a molder. He was a bench molder and a good one, though bench molding was the extent of his experience. Not then knowing his limitation, we later gave him a fairly stiff job on the floor and left him alone to make it. Walking around a couple hours afterward, I noticed he had nothing done. I went up to him and said "What's the matter?" "Why," he replied, "I never worked on the floor and can't figure out how to make this job. I made two flasks and they both fell out". "Yes", I replied, "and that one is going to fall out also. Shake it out and we'll make one." I threw off my coat and together we made one. Raising up from setting the complete cope on its drag, the man looked me in the eye and said, "Thank you, Russell, I think I'll be all right now." In that man's face I read an equation. It's an equation greater than all others and without which none other can be of any lasting value.

It's an equation of final values, an equation that has determined the truth or falsity of every social creed or doctrine ever propagated. An equation in whose majestic balance the fate of empires has been weighed and the transcendency of systems turned. An equation that evaluates the worth of every act, hope or condition of mankind. It's the equation every producing system has to reckon with. It's the basis of all cooperation.. It's the great, absolute, inviolate, everlasting human equation. It is the most perfectly balanced thing in the world, and it will make for the high tensile strength of your efficiency, the strict homogeneousness of your cooperation, the strong tenacity of your purpose and the advanced elastic limit of your success.

Iron Ore Output in 1915

In 1915, 55,526,490 gross tons of iron ore were mined in the United States, which was exceeded only by 1910 and 1913. The shipments aggregated 55,493,100 gross tons valued at $101,288,984. The quantity mined in 1915 was an increase of approximately 14,000,000 tons over the output of the previous year. The increase in quantity and value of iron ore amounted to 40 and 41 per cent, respectively. The average value per ton in 1915 was $1.83 compared with $1.81 in 1914. The Lake Superior district mined nearly 85 per cent of the total ore in 1915 and the Birmingham district, about 8.5 per cent.

The United States production of bauxite in 1915 was 297,041 tons valued at $1,514,834, an increase of 77,723 tons, or 35 per cent in quantity and of $445,640, or 41 per cent in value compared with 1914. Bauxite is the raw material from which aluminum is recovered. The consumption of aluminum in the United States last year was estimated at 99,806,000 pounds.

Making the Pattern for a Piston Valve Cylinder

Details of the Work of the Patternmaker, With an Interesting Exposition of the Intricate Core Work and Molding Methods Involved

By David Gordon

THE MODERN steam cylinder, especially of the piston-valve type, as a casting, usually is conceded to be an intricate piece of work, demanding absolute accuracy and soundness throughout owing to the pressure to which it is subjected. In its production it involves great care, skill and forethought by both patternmaker and molder. The factors which render these qualities so essential are many, but more particularly they are due to the sectional metal thicknesses which invariably are low, and combined with intricacy of design, allow of no latitude when accuracy is one of the chief considerations to be obtained. Furthermore, owing to the design of the cylinders, the necessary cored work is of such a nature that primary consideration must be given to this portion of the job as it usually requires a certain amount of interlocking to assemble it in the mold and, consequently, defines more often than not the molding methods to be adopted. Since this class of work, in the majority of cases, is of a standard character, it follows that the pattern and core boxes must be constructionally sound and durable, becoming in the hands of the molder and coremaker, perfect tools for producing these castings economically and efficiently.

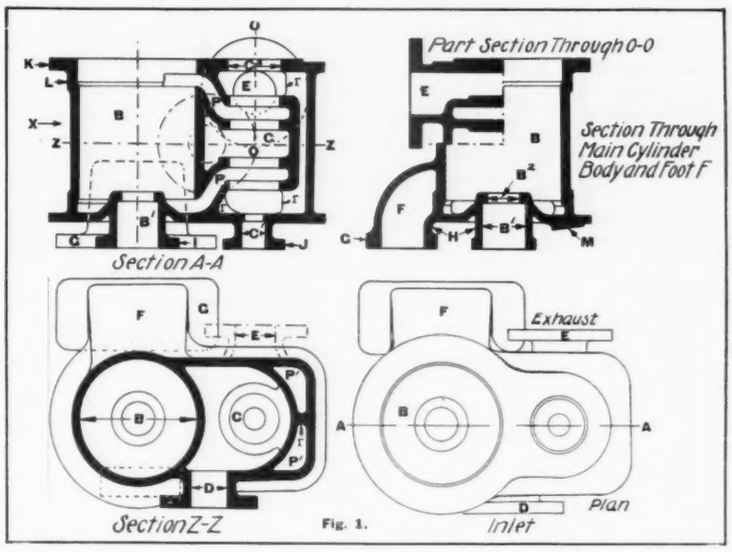


FIG. 1—VARIOUS VIEWS OF A MORE OR LESS COMMON DESIGN OF PISTON VALVE CYLINDER

Although molding methods vary according to design and size, the foundry practice is invariably the same. The castings are poured on end, since by so doing the slag is carried to the top, to a position where it has no deteriorating effect upon the casting proper. In the present article the patternmaking, molding and core work of a medium size cylinder is discussed.

Fig. 1 illustrates the various views of a more or less common design of piston valve cylinder, and assuming it to be of medium size, the pattern would be made in halves allowing it to be molded upon its side; the adoption of this method is for convenience in molding, as it can be made in two flasks, eliminating excessive lifts and insures accessibility for coring. The latter is an important consideration, as not only is there an intricate steam chest core, *C*, Fig. 1, to assemble in conjunction with the cylinder body core, *B*, but also the foot, *F*, of necessity must be cored out which entails further coring for the intervening space, *H*, between the foot, *F*, and the stuffing box, *B*, the latter projecting from the main cylinder body core. In Fig. 2 the completed pattern is shown in elevation, with also an inverted plan view—looking in direction of arrow *X*—illustrating the prints necessary with their arrangement, not only for convenience of assembling, but also to insure the stability necessary when the work is of the complicated and intricate character required. To specify the pattern parts in relation to Fig 1, before dealing with the constructional methods, *B* with B^1 are the prints for the cylinder. Referring to the body core, *B*, Fig. 1, C^2 and C^1, Fig. 2, are the prints for partly carrying the steam chest core, *C*, and as the latter has projecting from it the inlet and exhaust branches, *E* and *D*, Fig. 1, the prints *E* and *D*, Fig. 2, are respectively the same. The inlet and exhaust branch flanges are made loose over these prints, their position being defined by means of keys, *S*, over which they have a firm but sliding fit; *H* is the print for coring out the intervening space between the foot and stuffing box and is made flush with the face of the foot flange, *G*, owing to the recess formed around the stuffing box B^1 at the base of the cylinder body, *B*. This also entails coring and the work is simplified by enclosing the whole within a semi-circular print *I*, this being preferable to a shallow print, forming a half flange *I* to shape in the pattern, as it must be remembered that the other half is contained within the print *H*. To core out the interior of the foot, *F*, a pocket print, *O*, is required and extends to the pattern joint the distance, *f*, being the width of the required lightening hole in the foot, *F*. The stuffing box, *C*, of the steam chest, with its flange, *J*, is formed to the correct shape, as shown; *M* is the pillar facing and is a loose piece, screws being used for its attachment in this instance, but in some cases a dovetail is preferred if both tail and socket can be formed of metal, otherwise screws are more efficient and tend to greater accuracy, as dovetails, if formed of wood, tend to bind and shrink, causing endless trouble and annoyance. As already stated, the cylinders invariably are cast upon end and a head is required. This is formed upon the pattern in preference to having the molder cut it out of the mold and at *A* the required head is shown, being formed around the base of the body print, *B*.

In building the pattern, the center portion, *b*, Fig. 3, is formed by a combined lagging and boxing method, two end blocks, *A*, Figs. 3 and 4, supporting the lags which form the cylindrical portion and also the cross pieces required for boxing the steam chest portion. In cases where the inlet and exhaust branches project from the cross pieces forming the steam chest, these are made thick enough to allow the

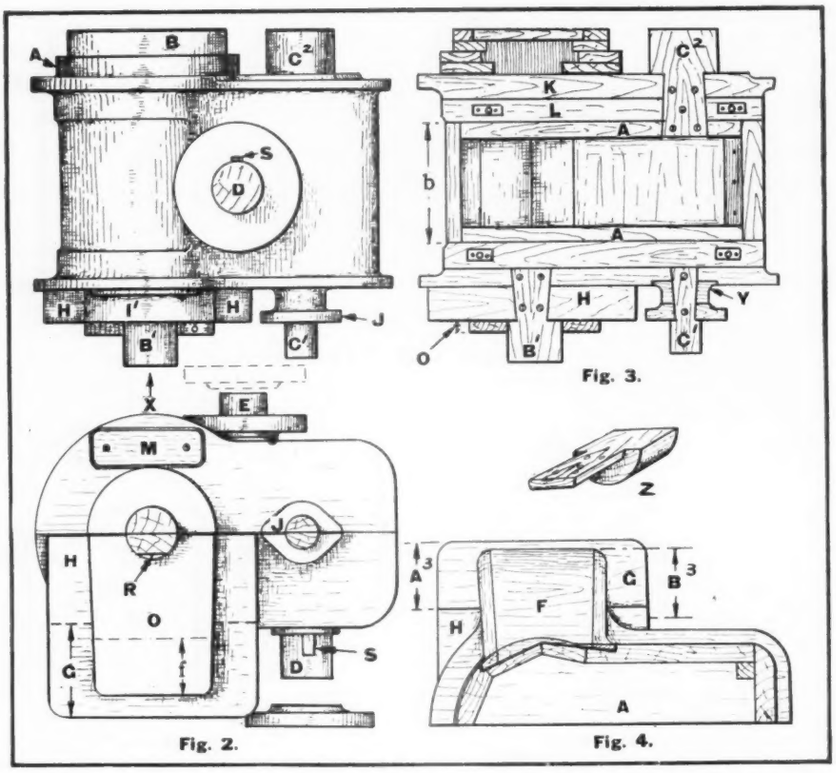


FIG. 2—INVERTED PLAN AND ELEVATION OF THE COMPLETED PATTERN. FIG. 3—DETAILS OF THE PATTERN SHOWING THE PRINTS. FIG. 4—PATTERN WITH THE FOOT, *F*, ATTACHED

fillets at the branch basis to be cut from them, as by so doing feather edges are avoided and in this class of work attached fillets of any description are undesirable, as even the best of them tend to rise at the edges, causing mold fractures with their incidental annoyances. The cylinder belt portions, *L*, Fig. 3, with the steam chest part continuous with it, is formed from the solid material and contains the fillet required to be formed around the smaller cylindrical portion contained within *b*.

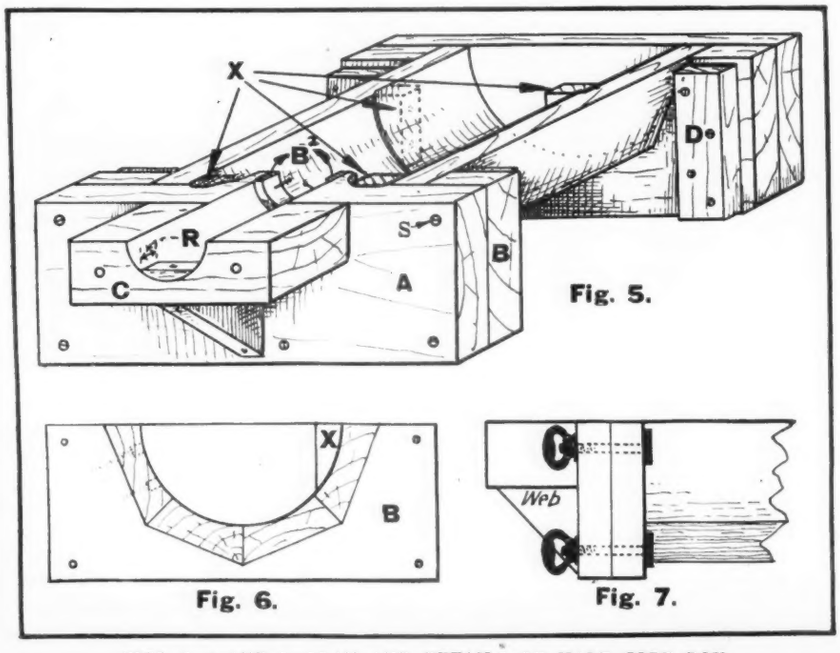
The fillets required where the flange, *K*, comes into contact with, *L*, is cut from *K* with the facing which forms the valve cover joint. The lower flange, with the intermediate piece between it and *b*, is formed in a similar manner to *K* and *L*, differing only when the foot, *F*, is required. The latter is boxed, its sides supporting the cross blocks, which are well stayed to insure stability and is fitted into and not against the main body as shown in Fig. 4, the objective gained being the avoidance of weak edges. It is well glued and screwed into position, and as its flange, *G*, is partly contained within the print, *H*, this is formed in part from the latter, the amount being A^3, which is the distance from the edge of the flange, *G*, to the point where the round edges of the foot commence as indicated by the distance B^3, which is the width of the foot where it comes into contact with the flange, *G*. The gland, C^1 Fig. 1, is formed by two pieces, the circular form where it comes into contact with the base of the steam chest being fitted-in as shown, thus allowing the fillet, *Y*, Fig. 3, to be formed from the portion which makes this latter piece. The print, *B*, with the head piece, *A*, is built-up by segments and is firmly glued and screwed upon *K*, the building-in of segments lessening the shrinkage and warping effects incidental to all wood. The prints, B^1, C^1 and C^2, Fig. 3, are attached by a dovetail as shown at *Z*, and they are first wholly turned. This method is preferable to circular fitting as the socket bed cut in the main body can be more easily and quickly formed, at the same time not lessening the strength of the pattern, which would obviously occur if a bulky, circular groove were used.

Pocket Print

The pocket print, *O*, Fig. 3, extends to the joint and is cut to encircle the print, B^1, this giving greater unity between the various pieces as the print, *H*, is attached to the base flange of the cylinder and is held in position by the fit of print, B^1. The inlet and exhaust flanges are built-up in segments and are made a sliding fit over the print; *E* and *D* also are cut to receive the keys, *S*, Fig. 2, for retaining them in a definite position. The intermediate piece between the flange and the fillet formed upon the part of the steam chest, with its prints, is turned up from hard wood being spigoted through into the boxed-up portion of the piece, *b*. It will be noted that a flat section is formed upon the print B^1 at *R*, Fig. 2, this being necessary to define the position of the circular body core in the mold.

Rapping and lifting plates are attached across the joints of both half patterns, being strongly screwed into position. After every screw is well stopped-up, the pattern is body varnished inside and out, the outside being smoothly sandpapered after each coat of varnish is dry until a full, hard, body surface is obtained.

From the foregoing it will be noted that wherever possible, lagging and boxing-up are adopted, as far as possible,



FIGS. 5, 6 AND 7—PLAN AND DETAILS OF HALF CORE BOX

thus lessening the weight, economizing timber and limiting the defects of shrinkage and warping which are more prevalent when the whole pattern is built-up of consecutive layers. This method only is acceptable in the smallest types of cylinders, but is economically false when applied to medium or large sizes.

For making the various cores, foundry conditions and conveniences obviously are important considerations in relation to the core producing methods to be adopted, as for example, the body core required for *B*, Fig. 1. In some cases, this may be conveniently struck-up on the core lathe, with the strickling board in position where it forms the rise at the cylinder base, while the neck of the stuffing box is made loose and may be withdrawn by a slight circular movement. If this method is adopted, the steam chest port cores, *PP*, Fig. 1, where they come in contact with the core, *B*, would be made to fit around the latter, as against fitting into this core.

Interlocking Cores

By fitting or interlocking one core with another, greater stability with lessened risk is obtained, and this safer and more accurate method is obtained by forming the core by means of a box as shown in Fig. 5. This half core box—one-half core box only being required as the half cores can be easily and accurately jointed—is made up by means of lags which are attached to end blocks, as at *B*, Fig. 6, the end blocks being cut to receive the flats of the lags. The recessed portions of the cylinder are cut from these, being shaped by means of a templet after the smaller main body part has been cut through the entire lengths of the lags. The half box is enclosed and the end piece, *A*, Fig. 5, is turned to form the desired rise at the cylinder base, with also the stuffing box. The complete length of the latter is obtained by means of a projecting piece, *C*, which, at its extremity, has a flat section, *R*, formed for defining the core's position with its print, *R*, Fig. 2. This projecting piece is well glued, screwed and strongly stayed by means of a web to the end piece, *A*, Fig. 5. To remove the cores from the box, this end piece with the piece which forms the neck of the stuffing box, owing to the base rise and stuffing box portion projecting, is required to work loose. The stuffing box is parted diametrically into two pieces, being held in position by skewers and to effect their removal, after the core is made, are withdrawn in the directions indicated by the arrows at B^2, Fig. 5. The piece, *A*, may be attached by screws to the end block, *B*, which is strengthened by battens as at *D*, the screws, obviously being removed for separating it as a loose piece. If the number of cores required is large, it is preferable to utilize clamps as shown in Fig. 7, which pass through close-fitting holes in the pieces, *A* and *B*. This is an advantage, since if screws are used they invariably lose their thread, necessitating further counter-sinking of the screw head, or alternatively, require new holes.

In making these cores, cinders are used for venting, which surround a perforated iron barrel, stability being given to each half core by means of a well prodded grid. When the half cores are placed together, the grids are well wired through so that complete rigidity between the half cores is obtained. The core required to form the steam chest interior, *C*, Fig. 1, is made in conjunction with the ports, *PP*, with also the inlet and exhaust branches, *E* and *D*,

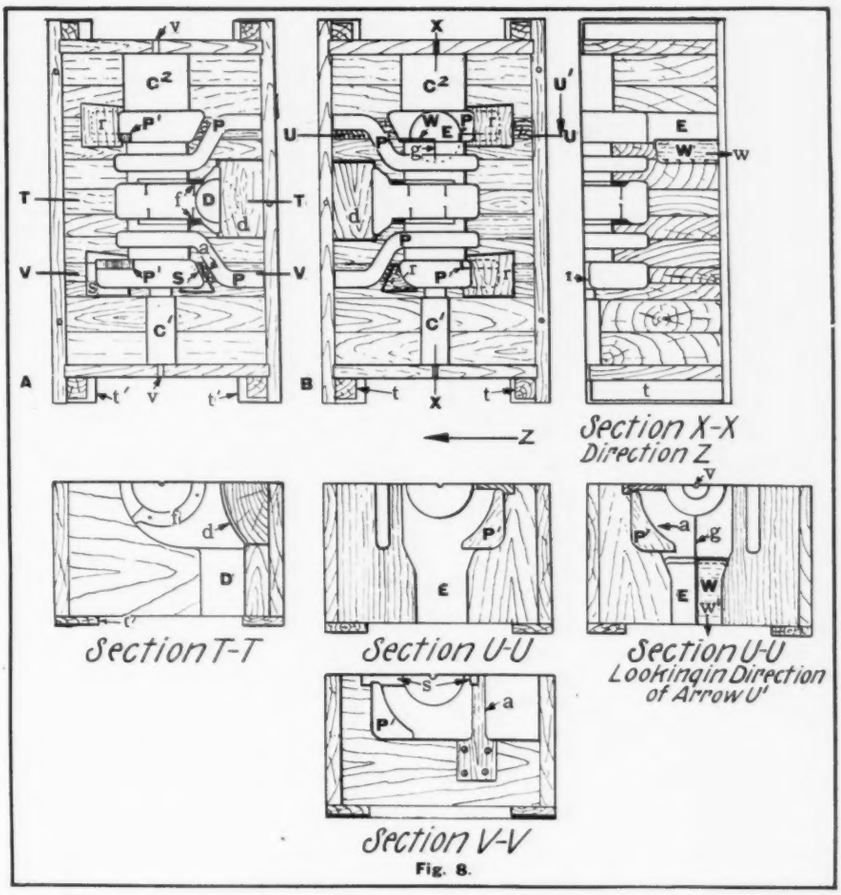


FIG. 8—BOX FOR FORMING THE CORE WITH THE PORTS AND BRANCHES AS INTEGRAL PARTS

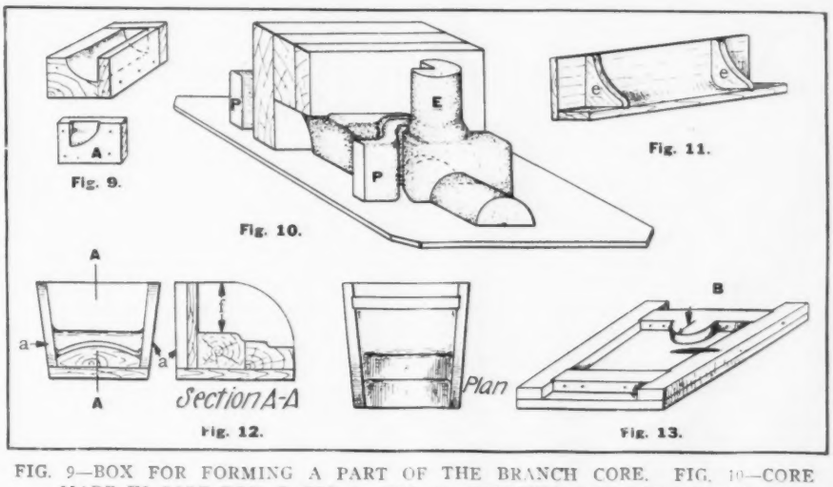


FIG. 9—BOX FOR FORMING A PART OF THE BRANCH CORE. FIG. 10—CORE MADE IN CORE BOX, *B*, FIG. 8. FIG. 11—STRICKLE BOX FOR FORMING EXHAUST PASSAGE CORES. FIG. 12—CORE BOX FOR MAKING THE FOOT CORE, *F*, FIG. 1. FIG. 13—BOX FOR FORMING PART OF POCKET PRINT

This method is preferable to making the core in various units, afterwards linking and joining the various pieces together to form the complete core. As an example of this latter method applied to the core in question, the port or passage cores *PP*, would be made separately, also the branch cores *E* and *D*. These cores would be arranged to link onto or fit around the remaining portion of the core extending from C^1 to C^2, their respective positions being defined by means of flats formed to denote this. It will be obvious that there is great danger, during casting, of the metal wash displacing one or more of the various parts. Assuming that the joints have been pasted together for purposes of stability, the drying of these joints is always questionable, and if not thoroughly insured, a *blow*, with its usual results, is to be expected.

To form the core with the ports and branches as integral parts, a box is made in halves, as shown at *A* and *B*, Fig. 8. Owing to the intricate design of this core, the main consideration, obviously is its relief from the box without fracture and this is effected by forming the shapes required out of loose pieces of various thicknesses, which are retained in position during the make-up of the core by a surrounding framed box.

Use of Frame Box

This framed box is constructed by recessing the sides to receive the end pieces and the whole is kept in position by screws, which pass through the sides into corner blocks, *tt*, Fig. 8, *B*. These corner blocks are attached permanently to the end pieces, their grain running in a transverse direction, and by their use a firmer screw-bind is obtained; also, they act as battens for keeping the end pieces from warping and give a greater bearing surface for keeping the sides and ends in position. Since the pieces contained in the box must be loose, bearing strips are attached to carry them and the amount of overlap, or bearing, for this purpose should not be excessive as they are removed with the box sides when the frame is knocked down to relieve the loose pieces. The thicknesses of the various loose pieces contained within the frames depend upon the facilities provided for their separate withdrawal from the core.

It will be noted that all fillets are cut from the solid material, one piece containing the fillet of the piece contiguous to it, which latter, as a general principle, is straight-through cutting. As the ports *PO*, Fig. 1, are at an angle with the main body of the steam chest, *C*, this creates, in some of the pieces which form the core box at these positions, shortness of grain. Where this occurs, the weak portions are cut away and other pieces substituted, as shown at *a*, in the sectional view *VV*, Fig. 8. These pieces are half-lapped into the main blocks in conjunction with which they are required and a harder and more durable wood than pine—this being the material of which the box is mainly formed—is an advantage. Where the steam chest encircles the main cylinder, this involves, in these core boxes, the pieces, *d-d*, which are relatively the same for forming this encircling part and are to have a loose fit owing to their overlap of the core. These loose pieces are kept in position by means of seats cut in the blocks contiguous to their ends, fillets being formed upon the pieces, *d*, as shown. In the box, *A*, Fig. 8, the inlet branch core, *D*, is formed with the result that one of the

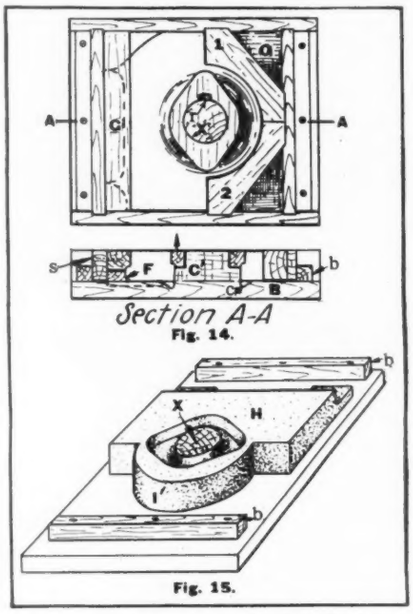


FIG. 14—BOX FOR INTERMEDIATE CORE, *H*. FIG. 15—CORE MADE IN THE CORE BOX, FIG. 14

blocks is parted into two pieces, these are kept definitely in position during the ramming of the core by screws passing into them through the sides. The separating web, *r*, Fig. 1, which divides the exhaust into two passages, is partly made in each half box, *A* and *B*, Fig. 8. They also are required to be loose and seats, *S*, are cut in the necessary blocks to accommodate them.

The circular facings, *f*, are required to work loose and these usually are made of metal owing to their small sectional thickness. They are attached by means of skewers, two in each facing, and these are withdrawn during the assembly of the core, after the position of each facing has been definitely assured in the surrounding sand of the core.

The exhaust branch, *E*, Fig. 1, where it comes into contact with steam chest, in this example is elongated, giving an elliptical form at the branch base, from whence it tapers to the circular. This obviously effects the core in a similar manner if an equal metal thickness is required, and in the box, *B*, the branch core, *E*, owing to the elongation, is formed by under-cutting one of the blocks, which is apparent if the section *OO*, Fig. 1, is considered. Owing to the proximity of one of the ports, *P*, this undercut elliptical portion, cannot be entirely formed, since if it were, the release of the block only could be obtained by fracturing the core and it is thus only possible to part-form this core, the remainder being made as a separate unit. To relieve the portion of the core formed, the block out of which the undercut is taken, is divided centrally at *g*, this allowing the divided block to be drawn away in the direction of the arrow, *a*, section *VV*, the portion drawn being that which has no port core to encounter. The remaining part of this block cannot be drawn in this manner as the port core, *P*, blocks its withdrawal and in this case a print, *W*, is utilized, which extends to the branch extremity and absorbs that portion of the core which would be formed if under-cutting could be adopted in a similar manner to the other part of the block. This print allows the half block to be lifted upward in the direction of the arrow, *W*, this being more clearly understood when the assembly of the core is explained. To form the remaining portion of this branch, a box, Fig. 9, is required, *A* being one end piece removed. The core formed by means of this box is pasted and well sprigged into position, making up the full branch required. The holes cut through the frame ends *V-V*, Fig. 8, are made the size of a suitable core bar which forms the central vent of the core.

Withdrawing the Core Sections

The cores formed by these two boxes, *A* and *B*, are made separately, being afterwards jointed and wired together, but for the convenience of the pattern-maker, to insure accuracy between both half boxes, dowels are placed into the frames.

The procedure for withdrawing these cores from their respective boxes after they have been rammed and well ironed throughout, is first to remove the piece, *d*, with the web pieces, *rrr*. An iron core plate is placed upon the core surface and the whole is inverted. The frame is next unscrewed and removed, the various blocks being then withdrawn from the core in a direction suitable for their release, namely sideways or upwards. In Fig. 10 the core made in the box, *B*, is shown, partly relieved, and the amount of the branch, *E*, not formed is clearly indicated. When

the blocks are cleared the facings are next removed by withdrawing them into the space provided by the blocks to which they are attached. The cores are then placed into the oven and thoroughly dried, during which period the vents are opened, if wax wire has been used for venting purposes, and for this type of core it is very suitable. Care must be taken that all vent holes are stopped at the ends of the ports, *PP*, the vent outlets being the extremities of the branches, *E* and *D* and the prints, C^1 and C^2.

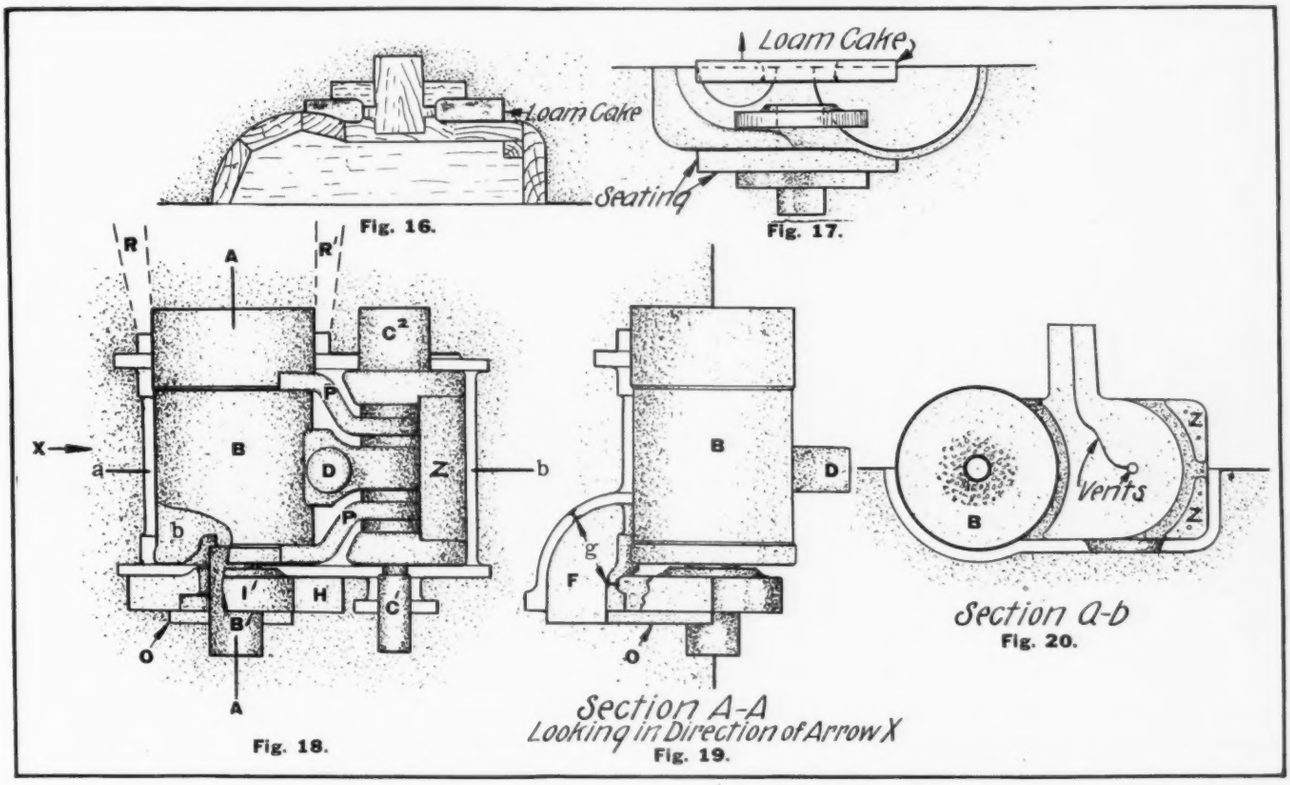
As the exhaust passage, *P P*, Fig. 1, is divided by means of a rib, *r*—which for the sake of clearness is not given in section in the elevation of Fig. 1—exterior shape being struck-up by means of a strickle working upon the side pieces, *aa*. The interior shape, namely where this core encircles the main cylinder, is fully formed by means of blocks cut to the required shapes, the distance, *f*, being the minor width of the lightening hole for which this core is required. In the pattern, Fig. 2, a pocket print is made to receive this core, but in this box the full core print is not made as it is simpler and equally as effective to form the remaining part of the print not contained in this box, by means of another box, Fig. 13. This box makes up the part required—which is really a stopping-off piece—for the pocket print *O*, Fig. 2. The semi-circular piece, radius B^1 is required to form a part seating for the main body core print, B^1, Fig. 2.

The intermediate core, *H*, required for forming a part of the exterior of the foot, *F*, with its flange, *G*, and also the stuffing box, or gland, B^1, is made by the box Fig. 14. This box is framed, and by means of the pieces, *1* and *2*, which are attached permanently to the frame, the required shape of the core's exterior is made.

Upon a bottom board, or plate, out of which the rise, *C*, at the cylinder base is turned, also those portions of the lower flange absorbed by the print, *H*, Figs. 2 and 4, register battens, *b*, Fig. 14, are attached. These have a sliding fit between the frame sides and define the position of the frame to the bottom plate. Incidentally they act as battens for keeping the plate from twisting and warping, as the frame in this respect, is of no advantage, since it is required to work loose from the bottom board. The portions of the foot, *F*, which comprise part of flange, *G*, and the outer shape of the foot at its interior position—as it will be remembered that the print *H* extends to where the curve of the foot edge runs into to flat of the foot side—also are attached to the frame, *S*, and shown at *G* and *F*, in Fig. 14. The gland, B^1, except its flange, is attached to the bottom plate and its flange works loosely over a recessed portion of the gland, *X*, Figs. 14 and 15, its position being defined by the stop, *r*.

The core is relieved from this box by first removing the gland flange, after which the frame and those parts attached to it, *G* and *F*, are lifted away, Fig. 15. A core plate next is placed over the core, the core is inverted and the bottom plate then is withdrawn by an upward lift. This core is pricked through for venting purposes and is reinforced by a light iron grid.

The mold for this cylinder is dry sand and is contained within two flasks. The molding of the pattern is a comparatively simple job, and assuming that it is well *ironed* for strengthen-



FIGS. 16 AND 17—THE LOCATION OF THE LOAM CAKES AND DIRECTION OF THEIR WITHDRAWAL. FIG. 18—HOW THE CORES ARE ASSEMBLED. FIG. 19—SECTION *A A*, FIG. 18. FIG. 20—SECTION THROUGH *a-b*, FIG. 18

this, of necessity, is made of two cores which are afterwards attached to the steam chest core, *C*. Their position in relation to this core is defined by means of prints P^1P^1, Fig. 8, which also form seatings for them. These cores are made by means of a strickle box Fig. 11, the full shape of the core being obtained by means of a straight edge working upon the ends, *ee*, sweeping away the superfluous sand until the latter is in perfect alignment. These cores are vented and ironed in a longitudinal direction, the vents being drawn into the main core, *C*, of which they thus form an integral part.

The core box for making the foot core, *F*, Fig. 1, is shown in Fig. 12, the

ing purposes, also well vented throughout, presents no difficulties. Except the two branch flanges, *E* and *D*, both half patterns are straight lifts and the former are removed from the mold by means of false cores. These false cores are made from the pattern by a molder who, previous to molding the pattern, places loam around the branches in excess of the flange diameters. This excess must be sufficient to form a seating in the mold, which will be on the level of the undermost portion of the flange, Fig. 16. A piece of bent wire is bedded into the loam and assists in the removal of the loam cakes after they are made. After their removal they are thoroughly dried. In molding the pattern, these loam cakes are rammed in their respective positions with the loose flanges. After both half patterns are withdrawn, the loose flanges still remaining in the mold, these loam cakes, which are virtually false cores, are removed and the flanges withdrawn, as shown in Fig. 17. The loam cakes are then returned to their former position, well-sprigged into position, and any fractured edges are repaired.

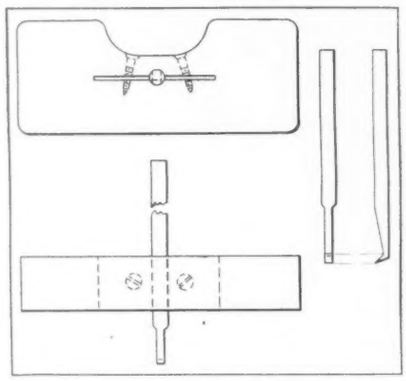
In cases where the branches are of excessive length, the loam cakes are placed upon the flange surfaces and over the prints. The procedure for the removal of the loose flanges in these instances, follows: The loam cake is placed into position and rammed-up with the pattern until it is surrounded, but not covered by the sand. The loam cake then is withdrawn and being in excess of the flange diameters, allows the flanges to be removed, when the cakes are returned to their former positions, the cakes making a seating while being rammed which extends beyond the rims of the flanges. The making of the mold is now proceeded with, minus the loose flanges.

Assembling the Cores

In assembling the cores, the foot core, *F*, is placed first into position and support is given to this core by means of chaplets, *g*, Fig. 19, and also, in the other direction, pipe-nails. These chaplets must not be placed at a position where the cylinder body may be affected by their use as their complete fusion cannot always be assured. The necessity for their use is obvious as the thickness of the pocket print, *O*, Fig. 2, which gives support at one end, is not sufficient to insure stability. The making-up piece of the pocket print, *O*, made by the box, Fig. 13, next is placed into position and secured, its perfect alignment with the print, B^1, Fig. 2, impression and the semi-circular piece, *B*, Fig. 13, being insured so that a straight bed throughout be given for the print cores, *O*, Figs. 18 and 19. Before placing the remaining cores into position in the mold they are first assembled, the port cores, *PP*, of the steam chest core being fitted into the recesses made by the pieces, *X*, Fig. 5, in the main body core, *B*. Over the stuffing box core, B^1, formed with the core *B*, the core I^1-*H*, Fig. 18, which forms the intervening space and also the stuffing box exterior, B^1, is looped over and the three cores carefully lowered into the print impressions *A*, B^1, C^1 and C^2. The core I^1-*H* being loose over the core, B^1, its position is defined by the print *H* only, I^1 giving it top stability.

Trying the Mold

The core, C^1, also has to fit into the prints of the branches, *E* and *D*, and as these branch prints are covered while these cores are lowered into position, they are well tapered at the print ends so that their admittance is sure, accuracy being obviously obtained when they completely rest into the full print lengths. A trial with the mold is made over the various cores, clay balls being placed at various positions which, becoming compressed between cores and



A HANDY PATTERNMAKERS' ROUTER

mold, define the metal thicknesses that are obtainable.

The vents are drawn off the print extremities between the mold joint of both half molds, except the vents from the branches, *E* and *D*, which are drawn off the sides, this being their position when the mold is turned on end for casting after the mold and cores have been previously securely fastened into position. A large runner, *R*, is formed for the quick delivery of the metal into the mold. Also an equally large riser, R^1, Fig. 18, is provided, which tends to act as a feeder. If, owing to the drop of the metal, any parts of the mold or cores are liable to be washed or fractured, precautions against this are taken by adopting a bottom runner which feeds the lower portions of the mold and is cast into *first*, this metal acting as a cushion to the top-fed metal.

In the present example those portions of the steam chest, *C*, out of which the fillets at the base of the branches, *E* and *D*, are formed, should be interchangeable and only are screwed, but not glued into position. In the case of the foot, *F*, with its flange, *G*, and the print, *H*, this obviously can be made to change over easily, but would differ in the respect that the flange of both half patterns would be the same, the flange not forming any part either of the foot, *F*, or the print, *H*. The fitting portions of the foot into the main cylinder body, in each case, should be adopted, as the parts recessed for fitting purposes are easily made. In reference to the valve box, *C*, this would be affected in some of its blocks, especially where the branches occur, and in these instances other blocks should be substituted to obtain the desired right or left hand location.

A Handy Patternmakers' Router

By S. L. Cook

The simple idea suggested herewith is really an application of an old principle in a new dress. The router is one of the handiest tools in the patternmakers' kit and there are almost as many different styles as colors in the rainbow. The attractive features of the tool shown in the accompanying illustration are its cheapness and weight, since only the cutter needs to be carried in the tool kit, which appeals to the traveling fraternity who find it necessary to curtail the weight of their baggage. The router, as herewith shown, consists of a block of wood about 6 inches long, 3 inches wide and 2 inches thick. It may be pine, mahogany or any other stock at hand. The writer made one of pine and it proved very satisfactory. The router iron is 5/16-inch in diameter and a hole of this size should be bored in the center of the block. With a small keyhole saw a slot should be cut on either side of this hole. If no keyhole saw is handy, cut the slots from either end with a band saw and glue pieces of wood into either end the thickness of the saw cut. Insert wood screws which will provide the necessary binding to hold the cutter firmly.

The cutter is made from a section of 5/16-inch drill rod, ground and filed to shape. The steel will be found to be quite hard and there is no need of tempering it, although it improves its edge to do so. Sharpen the cutting edge and place the cutter in the block. This will give as satisfactory a router as any patternmaker has ever used and it will not have a tendency to discolor the job as brass and aluminum routers sometimes do.

TAPERS AND ANGLES

By S. L. Cook

TAPER PER FOOT IN INCHES

	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
CORRESPONDING ANGLES FOR TAPERS														
No.				1°	1°	1°	2°	2°	2°	3°	4°	4°	5°	5°
of	17′	35′	53′	11′	29′	47′	5′	23′	59′	34′	10′	46′	21′	57′
in.	54″	48″	44″	36″	30″	24″	18″	10″	42″	44″	32″	18″	44″	48″

TAPER PER INCH IN INCHES

1	0.0052	0.0104	0.0156	1/64	1/64	1/32	1/32	5/64	5/64	1/16	5/64	5/64	3/32	7/64
2	0.0104	0.0208	0.0313	1/64	1/64	1/16	5/64	5/64	7/64	1/8	5/64	11/64	1/16	13/64
3	0.0156	0.0312	0.0469	1/16	5/64	3/32	7/64	1/8	3/32	1/16	7/32	1/4	9/32	1/16
4	0.0208	0.0417	0.0625	5/64	5/64	1/8	9/64	11/64	13/64	1/4	17/64	21/64	3/8	25/64
5	0.0260	0.0521	0.0781	7/64	1/8	5/32	9/64	13/64	17/64	5/16	21/64	25/64	15/32	29/64
6	0.0312	0.0625	0.0938	1/8	5/32	3/16	7/32	1/4	9/32	3/8	11/32	1/2	13/32	5/8
7	0.0365	0.0729	0.1094	9/64	3/16	7/32	1/4	17/64	21/64	7/32	25/64	29/64	31/64	33/64
8	0.0417	0.0833	0.1250	11/64	13/64	1/4	17/64	21/64	25/64	1/2	29/64	33/64	3/4	37/64
9	0.0469	0.0937	0.1406	13/64	15/64	9/32	21/64	3/8	25/64	9/32	33/64	3/4	37/64	41/64
10	0.0521	0.1042	0.1563	13/64	17/64	5/16	23/64	27/64	29/64	5/8	37/64	41/64	21/32	1 5/64
11	0.0573	0.1146	0.1719	15/64	9/32	11/32	25/64	29/64	33/64	11/16	41/64	45/64	1 1/32	1 9/64
12	0.0625	0.125	0.1875	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4

(*Continued on Data Sheet No.* 214.)

TAPERS AND ANGLES

By S. L. Cook

(*Continued from Data Sheet No.* 213.)

TAPER PER FOOT IN INCHES

	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8	3
CORRESPONDING ANGLES FOR TAPERS														
No.	6°	7°	7°	8°	8°	9°	10°	10°	11°	11°	12°	13°	13°	14°
of	33′	9′	44′	20′	56′	31′	7′	42′	18′	53′	29′	4′	39′	15′
in.	26″	10″	48″	26″	2″	36″	10″	42″	10″	36″	2″	24″	42″	

TAPER PER INCH IN INCHES

1	7/64	1/8	9/64	9/64	5/32	11/64	11/64	3/16	13/64	13/64	7/32	15/64	15/64	1/4
2	15/64	1/4	17/64	17/64	3/16	21/64	23/64	3/8	25/64	25/64	7/16	29/64	31/64	1/2
3	11/32	3/8	13/32	7/16	15/32	1/2	17/32	5/16	19/32	5/8	21/32	11/16	23/32	3/4
4	23/64	1/2	25/64	27/64	5/8	29/64	15/32	3/4	31/64	33/64	7/8	29/32	31/64	1
5	27/64	5/8	29/64	31/64	25/32	29/64	27/64	15/16	29/64	1 3/64	1 3/32	1 1/64	1 1/64	1 1/4
6	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2
7	31/64	7/8	33/64	1 1/64	1 3/32	1 1/64	1 1/32	1 5/16	1 35/64	1 37/64	1 17/32	1 39/64	1 41/64	1 3/4
8	33/64	1	1 1/64	1 1/64	1 1/4	1 9/64	1 7/64	1 1/2	1 39/64	1 41/64	1 3/4	1 43/64	1 45/64	2
9	1 3/32	1 1/8	1 3/16	1 3/16	1 3/32	1 1/2	1 13/32	1 11/16	1 35/32	1 7/8	1 31/32	2 1/16	2 3/32	2 1/4
10	1 3/64	1 1/4	1 23/64	1 23/64	1 5/16	1 13/32	1 13/32	1 7/8	1 33/64	2 5/64	2 1/16	2 1/32	2 3/64	2 1/2
11	1 17/64	1 3/8	1 31/64	1 33/64	1 33/64	1 37/64	1 31/64	2 1/16	2 1/64	2 1/32	2 1/32	2 3/64	2 1/64	2 3/4
12	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8	3

THE FOUNDRY DATA SHEET, JULY, 1916

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

Defective Steel Castings and Their Remedies

A Brief Discussion of Some of the Underlying Difficulties Affecting the Operation of the Steel Shop and How They May Be Remedied

By J H D Eagan

STEEL castings of the same design made by different foundries will vary widely in quality and frequently, cast parts made from the same pattern in one foundry also will differ widely. This is more the result of differences in foundry practice and can be attributed largely to improper methods, the quality of the metal not necessarily being at fault. The steel foundryman has many problems to contend with, with which the iron foundryman is not confronted. This is due to the more rapid solidifying property and greater shrinkage of steel than iron.

Simple Design

Machinery and equipment builders who are large users of steel castings should have the various parts designed as simply as possible. Care should be exercised to avoid changing abruptly from heavy to light sections. As a rule, too little attention is given this feature and efforts to save weight and machining may result in internal defects and strains which only develop after the machine is in service.

It is poor economy to save pattern costs when the result is an increased loss due to defective castings, to say nothing of the machining of sections which develop flaws after a large amount of labor has been expended on them. Among many plant executives the idea seems to prevail that if only a few castings are required of a certain part, almost any kind of a pattern will answer the purpose and this, unfortunately, reflects on the foundry industry in general. In all cases, patterns should be prepared to meet the requirements of the foundry. It is still more advisable to combine the ideas of the foundryman and patternmaker, but the suggestions of the foundryman should predominate. If patterns are to be made at a point distant from the foundry, blue prints of the various parts should be sent to the casting plant to obtain suggestions of how the patterns are to be molded to expedite operations. If the design provides for sections that are too thin for the metal to fill to advantage, or if the sections adjacent to heavy sections are too thin proportionately, the foundryman should insist that the lighter sections be made heavier to insure sound castings. Before the patterns are delivered to the foundry, the pattern shop should note the location, size and shape of the gates, as well as the risers, together with their openings into the castings and these should be clearly marked on the pattern with paint.

Sometimes the casting is of such a form that openings for the gates and risers, of sufficient dimensions for the proper pouring of the metal and shrinkage of the parts, is impossible without adding extensions to the pattern at these points. If these extensions are necessary, they should be made by the foundryman and the cost should be borne by the purchaser, since it is to his interest that this is done in order to obtain uniformly good castings. As a matter of fact, this additional cost will average much less than the losses that otherwise might be entailed, including the cost of machining defective castings, delays incident thereto and breakage in service.

By providing the proper patterns and flask rigging, the element of human error is limited. Furthermore, close attention should be given the selection of the sand and its preparation for molding purposes, the venting of the molds and cores, and matching the core vents with the mold vents is another important feature which is overlooked more frequently in steel foundries than in gray iron plants. The molds should be well vented through the cope as well as at the parting lines.

Drying the Molds

When drying the molds the temperature of the oven should be increased slowly during the first six to 10 hours, depending upon the amount of sand contained in the molds. By this course of procedure the moisture in the sand of the small and large molds will be converted into vapor at practically the same time. After the moisture has been converted into vapor, the oven can be fired as fast as possible and the moisture throughout the entire mass will be eliminated uniformly. If, on the other hand, the oven is raised to a high temperature at the beginning, the molds will become skin-dried, thus sealing the moisture in the interior, rendering it much more difficult to eliminate. This procedure in drying molds has a tendency to temper the sand, as well as to dry the molds. Furthermore, this practice, to a large extent, will prevent the sand from burning onto the castings, whereas if the molds are improperly dried, castings cannot be shaken-out clean.

Importance of Shrinkage

Since the shrinkage of steel is nearly twice as great as that of gray iron, great care must be exercised in designing the patterns and in providing against shrinkage cavities in heavy sections, as well as strains at the junction of heavy and light sections. Shrinkage cracks and strains, to a large extent, may be overcome by the use of chills placed over heavy sections to prevent the drawing of the metal away from the lighter parts. This causes the heavy sections to cool almost simultaneously with those of lesser thickness. In many instances shrinkage may be provided for by chilling the metal in heavy sections with nails or pieces of bar steel inserted in the mold so that the molten metal will surround and cement with these chills in the casting. Great care, however, should be exercised in the use of such chills, since it is essential that they be not too large nor too numerous to prevent cementing with the molten metal. Chills on the surface of molds for steel castings, as a rule, are of little value.

Since molten steel solidifies quickly, the metal for casting purposes should be of a higher temperature than that used for pouring into ingots. In many steel foundries the tendency is toward economy in supervision, whereas the best results are obtained in shops where the assistant foremen have only a comparatively small number of molders to supervise. The inspection of castings is another factor of importance requiring attention and no castings should be shipped having surface defects.

Electric Furnace Construction and Operation---II

Advantages of This Refining Medium for Steel Foundry Operations—Ease of Manipulation, and the Addition of Alloys

By James H Gray

IN MAKING high quality steel there are two periods to consider. One is the period during which the charge is being melted down. At that time the scrap has an infinite capacity for absorbing heat, and if the arcs are buried in the charge an extraordinary amount of heat may be applied without overheating the furnace. The second period is that during which the purification and deoxidation of the molten bath is performed.

The refining and deoxidation, accomplished by chemical reactions between the bath and the slag cannot be shortened by forcing in current. In fact, when the charge is molten and hot, its capacity for absorbing more heat is gone and the walls and roof of the furnace cannot withstand an excessive temperature. Therefore, the supply of kilowatts must be cut down during the second period. Why not, then, further shorten the first or melting period by still greater application of kilowatts? First, the power company usually bases its charges for current on the maximum demand, and in order to protect ourselves during times in which the production is small for commercial reasons and during other periods of shutdown, and considering the relation between the power consumption during the two periods just referred to, we must compromise as to how heavily we power the furnace. Also such practical considerations as sizes of electrodes, transformers, weight of copper used and other points of furnace design must be thought of. The current capacities given in Table II, page 245, June issue of THE FOUNDRY, have been found in practice to fulfill the conditions just mentioned.

The foregoing has been on the assumption that cold charges are to be melted. When molten metal is transferred from a Bessemer converter or open-hearth furnace to the electric furnace for further refining, the problem is much more simple, and a capacity of from 100 to 150 kva. per ton has been found ample.

With alternating current, if pressure and current are in unison of phase, the product of these two gives the power available. Various disturbing influences cause a lag in the current phase, in which case the available power is less than the product of the two. The ratio between these two conditions is called the "power factor" and is expressed in percentage. If

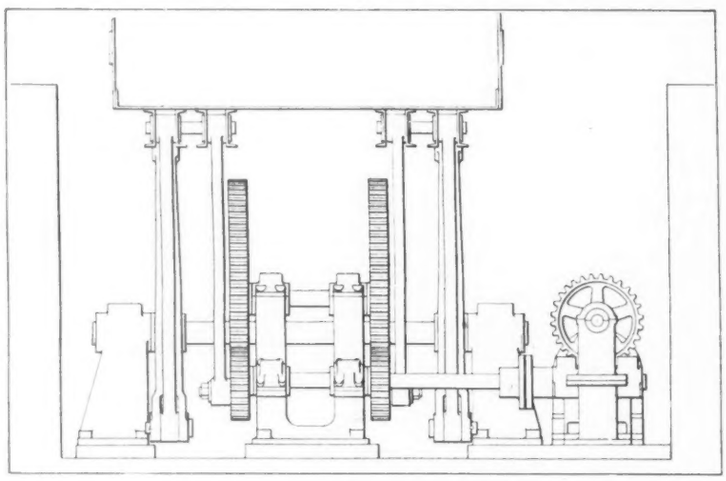


FIG. 5—DETAILS OF THE GEAR TRAIN OF THE TILTING MECHANISM, ELECTRICALLY-OPERATED

care be taken in the design of the furnace with regard to the disposition of the conductors with reference to each other, and to iron parts which may surround or lie close to them, the power factor may approximate 100 per cent.

Although in many kinds of work the men from whom power is obtained are content with a power factor as low as 80 per cent, nevertheless, a high power factor is considered desirable and some power companies even allow a bonus on the power bill varying with the amount the power factor is above a given per cent. A well designed arc electric furnace using as high as 60-cycle current should have a power factor of over 90 per cent, and many steel furnaces have a power factor of 95 per cent, furnace and transformers combined.

The electrodes of the electric furnace are heavy and must be lifted and lowered by suitable machinery to conform to the length of arc required to give the desired quantity of current flow. This mechanism is preferably operated by motors and the impulses given the motors require the use of automatic regulators detached from the furnace. The prime requisite is that they may be so dependable that the furnace operator may forget their existence and give all his attention to the steelmaking operation, just as we forget about the automatic regulator in an arc lamp. Another duty of the regulators is to keep the different current phases, employed on the furnace balanced, so that the power factor may not be disturbed and that the load may be satisfactory at the power house. To operate the electrode lifting mechanism by hand is an arduous task on large furnaces, besides requiring the attention of operators which should be employed elsewhere. The inability of the hand operator to avoid short-circuits and surges on the line may be minimized by the use of reactance in the transformers, or by coils at the furnace and regulators at the power house, but these devices are expensive and not as satisfactory as the automatic regulators.

As in other furnace construction, the design of the shell of the furnace should be concerned with having a structure which will retain its form under the difficult condition of containing brickwork which expands with heat. Also it must be rigid enough to carry the electrode supports without warping and getting the electrodes out of alignment. As the roof has to be replaced oftener than the side walls, the ironwork which carries the roof should be easily removable. This makes it difficult to use the usual buckstay and tie rod construction of the open-hearth furnace. This necessity is obviated if the furnace be made circular in form.

The drawing-out of a viscous slag,

maintaining a tap hole when making heats every 1½ or 2 hours when refining molten metal, etc., make it desirable to have the electric furnace tilting or rolling instead of stationary. If the furnace rolls, the spout descends below the floor level when pouring. This is not an objection while pouring heats from furnaces of larger size into a ladle in a pit. With smaller furnaces, where it may be desirable to pour directly into bull ladles, it is convenient to have the furnace tilted about a hinge located near the spout, so that the spout remains practically stationary during pouring. Various devices have been used for tilting, both hydraulic and electric types. Hydraulic power is not always available, and considering cost of maintenance, of operation and convenience in general, the electrical means is probably better.

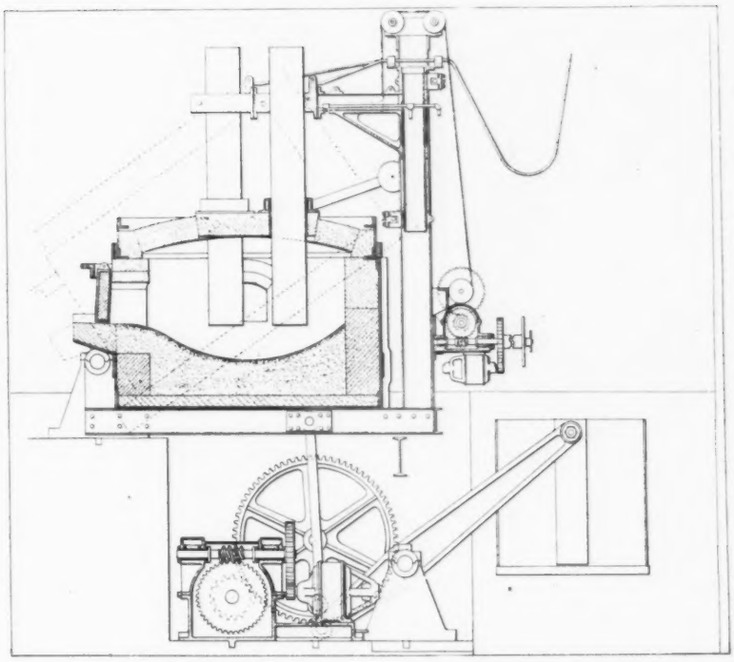


FIG. 6 — SECTIONAL ELEVATION OF A SMALL ELECTRIC FURNACE SHOWING THE DETAILS OF THE ELECTRICALLY-OPERATED TILTING MECHANISM, THE DOTTED LINES REPRESENTING THE POURING POSITION

Figs. 5, 6 and 7 show a design of electrically-operated tilting mechanism which has proved very satisfactory in service. The furnace is lifted by means of connecting rods attached to a large gear wheel. The large wheel is driven through spur and worm gearing by a motor. An advantage of this arrangement is that if the operator fails to cut off the current from the motor the furnace can do nothing but descend to its original position, and at the bottom and top positions of the stroke no matter which way the controller is operated the furnace will move in the desired direction. In the illustration is shown a counterweight which operates through levers to balance the weight of the furnace. With larger furnaces, which rest on rockers, the counterweight is not used, but in both cases the wheel and connecting rod arrangement gives a very smooth and readily controlled motion to the furnace. The standard of excellence in steel was formerly crucible steel. The inventors of the electric steel furnace aimed to produce steel equal in quality to crucible steel, but in such quantities that the cost of production would be lowered to a point where the margin of profit in tool steel would be increased, and high quality steel be made available for uses for which crucible steel was too expensive. Although the first commercial electric steel furnaces were operated in France and Sweden and then more generally adopted in Germany, it was in America that the possibility of using electric steel for lower-priced products, such as rails, was first recognized. And it was here that the first 15-ton units were installed, also that 3-phase current was first used on steel furnaces. Although the cost

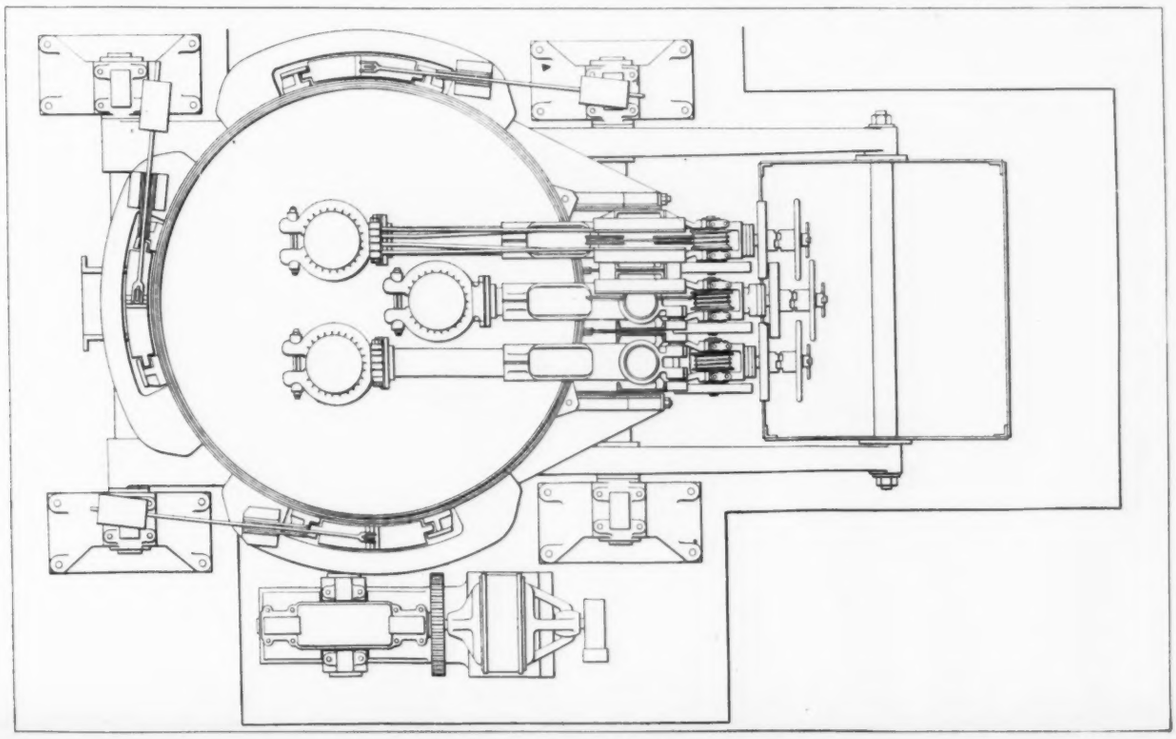


FIG. 7—TOP VIEW OF FURNACE SHOWN IN FIG. 6

of electric steel is still higher than that of open-hearth steel made in plants of large producing capacity, it appears likely that when electric installations are made of such a size that the production of a given plant equals that of a large open-hearth plant, the cost will not be enough higher to be prohibitive.

As a Finishing Furnace

To accomplish this, the electric furnace will be used as a finishing furnace, drawing its partially refined molten charge from either the bessemer converter or the open-hearth furnace, or from the combination of these in the duplex process. These remarks apply also to the production of electric steel for large castings which sell at a low price. Already the electric furnace of small sizes is successfully competing with the crucible and the small converter, either melting cold charges or refining molten metal. To compensate for the cost of electric current considered as a fuel, the possibility of using materials is an advantage to start with. As the crucible does no refining, materials for the charge must be of high quality and price, and the cost of crucibles and labor are important items. In the small converter a fairly high-priced pig iron must be used, and the metal loss from cupola to ladle is high. Cost of production is always high from small units, and even now the cost of production in an electric furnace is close to the cost of production from a small open-hearth furnace yielding the same amount of steel per hour or per day, and the advantage is with the electric furnace as regards its flexibility, inasmuch as it can be shut down overnight or over Sunday without keeping heat on and without damage to the furnace.

A greater consideration than cost is that of quality. The freedom from oxides and the low sulphur content of electric steel make it desirable for small castings. The ease with which the desired analysis may be obtained, either as regards carbon or the other elements, and the fact that alloys may be added in the furnace without loss of these expensive metals is a great advantage. It is thus possible to complete the entire steelmaking operation in the furnace and not resort to additions in the ladle. Also the higher density of this steel, as evidenced by freedom from blow-holes and greater specific gravity, and better physical qualities when tested should be recognized. As heat treatment is every day being more generally considered a necessity, electric steel best fulfills its purpose because of its great uniformity in results, freedom from cracking, and adaptability to greater ranges of temperature under heat treatment.

For certain purposes it is desirable to have numerous small very hot heats instead of fewer large ones. Steel of such high temperature as to readily pour small castings even in lots up to 5 tons can be obtained from the electric furnace without difficulty. The fact that the metal is free from oxides makes it possible to pour at these high temperatures without having wild steel. The excellence of electric steel, both as regards physical qualities and freedom from defects in machining, whether heat-treated or not, has led to its adoption for larger-sized castings, such as knuckles for car couplers, locomotive crossheads and castings of larger size used in particularly difficult service where quality and not price is the first consideration.

For Gray Iron

The electric furnace is now being successfully used to refine cupola iron for making malleable castings, and it is probable that a similar process would be valuable for making high-grade gray iron castings.

I have merely touched upon a few points in connection with the adaptability of the electric furnace to foundry purposes, but judging from the world-wide interest being taken in the electric furnace and the comparatively large number of units already installed, it seems probable that their use will become very general. As both steelmakers and foundrymen see their way clear to install units of large capacity, I predict that the annual production of electric steel will assume very noticeable proportions when compared with the tonnage of steel made by the older processes.

Coke Production in 1915

Coke production in the United States in 1915 amounted to 41,581,150 short tons, an increase of 7,025,236 tons, or 20 per cent, as compared with 1914. Of this total, 34 per cent, or 14,072,895 tons was by-product and 66 per cent, or 27,508,255 tons, was made in bee-hive ovens. The increase in the output of by-product coke in 1915 as compared with 1914 was 25 per cent, and in bee-hive, 18 per cent. The quantity of by-product coke made in 1915 was the greatest yet recorded and exceeded the output of 1914 by 1,358,195 tons. The total number of by-product ovens in operation was 5,481, against 5,142 in 1914.

The Metals Production Equipment Co., New York City, has established an office in the First National Bank building, Chicago, in charge of E. E. Adams.

How Scotch Pig Iron Was Named

The origin of many of the terms used in the pig iron and foundry business is buried in the mists of the past. Occasionally a term has come into use within such recent times that it can be traced to its beginning and the facts set down. All foundrymen and blast furnace operators are familiar with the term "Scotch" as applied to certain grades of charcoal iron which contain from 2.50 to 3.50 per cent silicon. The origin of this term goes back to 1890 when the practice of purchasing pig iron by analysis was just coming into vogue.

At that time, Scotch pig iron with a white fracture was imported from Canada for use as a softener. Analysis showed that charcoal iron with about 2.50 per cent silicon gave the same results as the genuine Scotch pig. Rogers, Brown & Co., Chicago, conceived the idea, through the suggestion of F. I. Foote, still in the employ of this firm, of applying the term "Scotch" to the charcoal iron. Accordingly "Hinkle's Scotch" was offered, and tried first at St. Paul and Minneapolis. From that time since, various Scotch irons have appeared and gradually, domestic irons of proper silicon content have come into general use as softeners. The real Scotch iron is no longer imported except on the Pacific coast.

Loss of Manganese in Cupola Melting

By W. J. Keep

Question:—How many points does manganese lose in melting? Can boiler castings be made which will machine easily with manganese 0.60 to 0.75 per cent; sulphur, 0.119 per cent and silicon, 2.10 per cent?

Answer:—The average of 76 different castings showed a loss of 0.15 per cent in manganese, 0.011 per cent phosphorus, 0.28 per cent silicon and 0.01 total carbon, while the sulphur showed a gain of 0.011 per cent. The hardening influence of manganese is not perceptible when less than 0.75 per cent. Sulphur should be kept under 0.09 per cent, but iron could be machined containing as high as 0.119 per cent. If any trouble is experienced, increase the silicon to 2.50 per cent by the addition of 50 per cent ferro-silicon. Undoubtedly, increasing the silicon by adding a pig iron containing a higher percentage of this element would improve the machining properties of the castings and it also will have a tendency to open the grain.

Fig. 1—The Cylinder and Leg Cores Divided; Foundry Practice of Sulzer Bros., Winterthur, Switzerland

Molding a Diesel Engine Cylinder

By Joseph S Horner

SECTIONAL and plan views of a cylinder for the Willans-Diesel engine manufactured by Willans & Robinson, Ltd., Rugby, Eng., are shown in Fig. 3. The cylinder body is cast in one piece with the A legs. The body receives the liner —the actual cylinder that makes contact with the three belts—leaving the water jacket space between, with the ribbings and the inlet and outlet passages, bosses, etc. The pattern must be lagged and boxed up, the whole of the interior must be cored, and the cores must be made in boxes. It is convenient to construct the pattern in two sections, dividing the cylindrical part from the A legs. The pattern, Fig. 3, therefore, will be divided where these two sections meet. The upper cylindrical portion, *A*, is lagged on cross-pieces and terminates just below the belt, where the A shape commences along the plane *a*. This belt and the enlargement at the top of the cylinder can be turned out of lagging strips cut thick enough to include them. Or, alternatively, the strips can be prepared of a suitable thickness for the body only, and blocks may be glued on them to form the enlargements. The latter is the better method though it requires more time and it saves a little lumber. The print, *B*, at the top end, only can be turned in one piece with the lags by making these very thick, and thick lags are objectionable because they are more liable to shrink. The print can be turned as a separate piece and screwed to the end cross bar; or a block (in halves of course), with the grain running longitudinally, can be used at that end, if sufficient size from which to turn the print. First it is planed in octagonal form to the same dimensions as the cross bars, and the lags are glued and screwed to it. The print is then turned on the portion which projects. The advantage of this method is that the print is integral with the body, and if any shrinkage should take place, it will remain circular. This is the method illustrated. At the other end the cylinder body can be attached to the A piece either with dovetails as shown, or by inserting screws between the cross bars of the two portions. The first method is preferable. The A frame section, *C*, Fig. 3, is made as a boxed-up pattern, and everything is cored. The shape is such that boxing-up admits of no alternative. Three cross bars are prepared in halves, of plain board, if of ordinary dimensions. In large cylinders these would shrink, and then the cross bars should be framed together with half lap joints and doweled in the central plane. Across

FIG. 2—THE MOLD WITH THE ONE PIECE CYLINDER AND LEG CORE IN PLACE

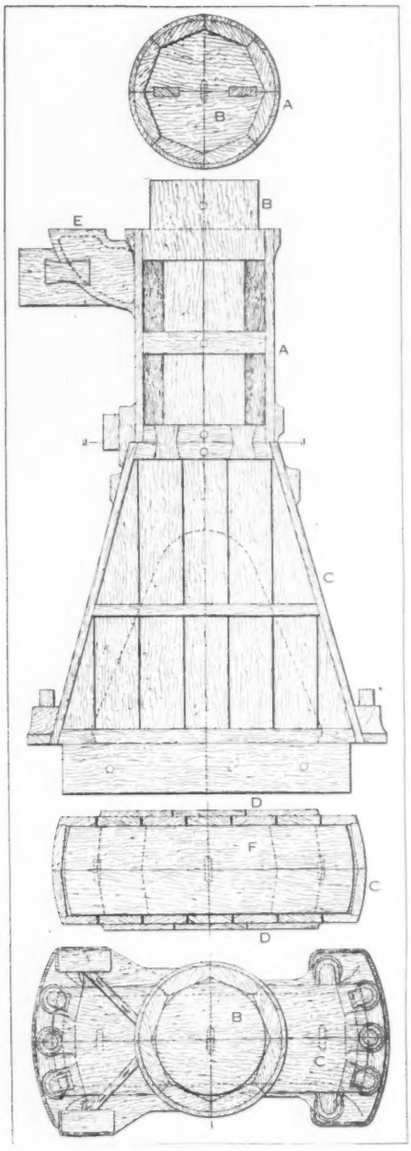


FIG. 3—THE CYLINDER PATTERN

these bars the narrow strips which form the flat and curved outlines of the pattern are screwed. The strips which cover the flat areas are made with open joints. Around the inner edges of the A frame, a raised and beaded flange is cast to which the casing sheets are attached. This is fitted onto the flat areas shown at *D*, Fig. 3, but not as a narrow flange. Only the outer edges of the bead are out on the pattern, the interior being formed by the core. The entire area enclosed is covered with strips which form a flat surface on which the core lies. To this plain body the feet are attached, as well as the two curved portions which form the extension of the cylinder body and a few bosses with their prints.

A detail that requires some consideration is the hold-down bosses on the foot, the holes in which, being large, are usually cored. Two methods are practicable, with little choice between them. They may, be left loosely skewered on, those in the joint face excepted, or a core print may be made to cover the area occupied by the bosses and all the bosses adjacent may be made in one core. The first method is illustrated. The loose bosses have pocket prints. The bracket, *E*, Fig. 3, boxed-up, being made separately and attached to the top of the cylinder along with the print for its lightening core.

The Cores

The whole of the interior must be cored out, and boxes must be made for this, since sweeping-up, even of the cylindrical body, is not practicable be-

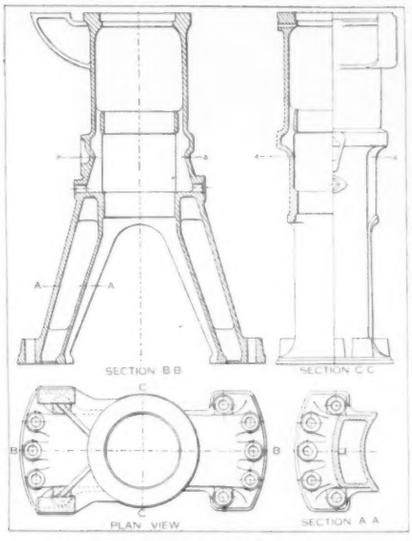


FIG. 4—SECTIONAL AND PLAN VIEWS OF DIESEL ENGINE CYLINDER CASTING

cause the central belt of metal with its stiffening ribs would complicate such a method too seriously. But one of the economies which is frequently adopted without being detrimental in the least to accuracy of results is to make half boxes only, the faces of which terminate in the longitudinal axis of the core. Then two half cores are made separately and either pasted together to form one core while green, or they are placed in the mold as halves. In this case the cylindrical portion at least is thus cemented, but the A portion may or may not be. Both of these methods are illustrated, one showing the practice in the foundry of Willans & Robinson, Rugby, Eng., and the other that of Sulzer Bros., Winterthur, Switzerland.

The reason why the interior of the A frame must be cored is that the inner portions are concave. The legs also are lightened with cores which are concave and convex in cross-section to correspond with the section, *AA*, Fig. 4. These are carried in print impressions in the feet. Elsewhere they have to be supported by chaplets. One print, *F*, Fig. 3, is made continuous to guide both the main or middle core and the two lightening cores. These could not be disconnected, because of the curved shapes and the very narrow bar of sand that would lie between them. The lightening cores are made to stop-off, or form the portion of the foot that lies between them and the main core.

Suitable methods of construction for the two half core boxes are shown. The half core box for the body portion, Fig. 5, may measure from 18 to 30 inches in diameter, and in any case it is a rather large box, always too large to be cut from the solid. The general scheme of construction is outlined in the end views, that at *A* being suitable for larger sizes and *B*, for smaller. At *A*, a base piece receives brackets *a, a*, on which strips are carried running longitudinally, the internal faces of which are cut to the radius of the core required. At *B* the strips are glued together.

But this is not a plain box having the same section throughout, and being also heavy, much advantage is gained, in time, economy of lumber and in degree of accuracy, by making it in sectional lengths united at the back with battens, *b, b*. Suitable locations for jointing are

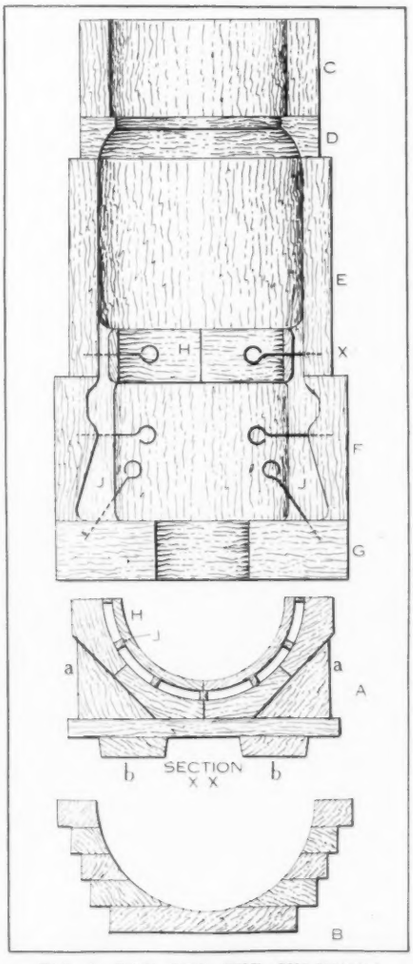


FIG. 5—BOX FOR THE CYLINDER CORE

shown, giving five sections. The print portion, *C*, at the top, is worked with gouges and planes. The shouldered portion, *D*, which receives the top part of the liner is worked separately; the plain, upper body, *E*, with planes and the lower part, *F*, is cut chiefly with gouges. A portion of it might be bored more easily in the lathe, but the complete circle would be required and one-half would be thrown away. The value of the timber wasted might be saved in the difference in time and in an increased degree of accuracy. Beyond the lowest portion of the bore at *G*, provision is made for a stud of sand which is to fit into a corresponding print impression in the A core to insure the correct centering of the two.

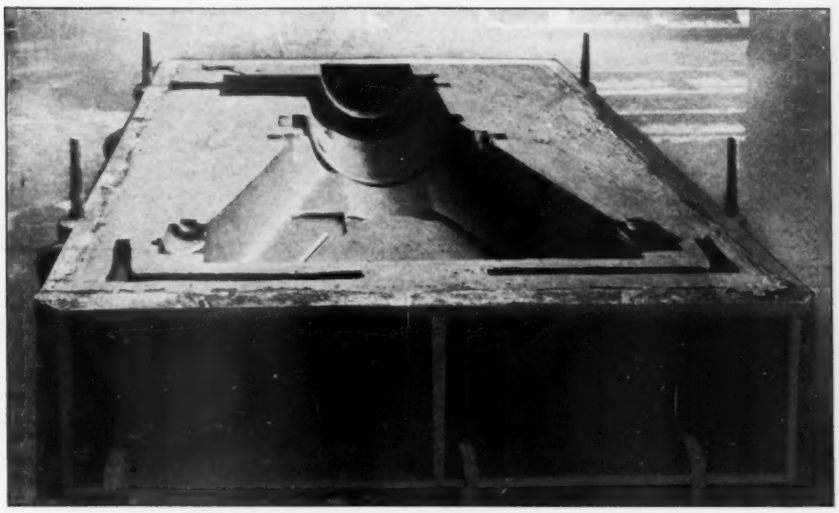


FIG. 7.—DRAG HALF OF MOLD SHOWING METHOD OF GATING

Making the Belt

The troublesome portion of this half core is the belt, *H*, which receives the central portion of the liner and the ribs which sustain it. The belt is made in two segmental portions to be withdrawn in opposite directions towards the box face. The ribs, *J*, Fig. 5, fitted into the box in radial relations, cannot be attached permanently, but must be loose. They can be secured best with skewers inserted as shown, which will be withdrawn when sufficient sand has been rammed around them to prevent shifting. Each half core is rammed on a grid and vents are cut in the joint faces.

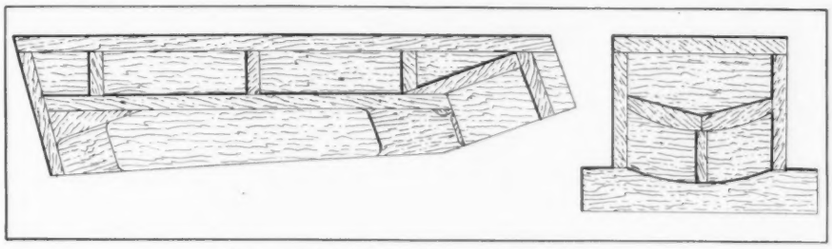


FIG. 6—BOX FOR LIGHTENING CORES

The half core box for the A frame is outlined in Fig. 9. Sides and ends are doweled on a plain bottom board constructed of narrow boards battened together with slightly open joints. The curves of the core at the sides, which form the concavities of the A frame, are formed as by fitting pieces at an angle and working through the curve with planes. The shapes at the box ends are modified as shown. A print, *A*, is fitted at the narrow end to receive the stud on the body core shown at *G*, Fig. 5. The core is rammed on a broad, open grid fitted with eyes for lifting. Vents are brought principally into and out from a body of cinders in the center. In addition gutters are cut deeply in the joints of the cores into which smaller vents pass and are thence conducted outside to the broad end of the core where all the vents escape.

Comparing the pattern, Fig. 3, with the casting, Fig. 4, it will be noted that a continuous print, *F*, is used, although three cores have to be carried, the one just named for taking out the interior of the A frame, and the two cores which form the hollow interior of the legs. One print is better than three in this particular case where the sand between the prints would be weak. Being made in this way, the cores meet each other in the print impressions and form the bottom of the leg where they meet. The sectional shape of the box for the lightening cores is illustrated in Fig. 6. Two sides and ends rest on a bottom board planed to the convexity of the interior. The concavity of the outer portion is produced by a strickle. The ribs are set in the box near the ends. The longitudinal section is outlined in Fig. 6, which corresponds with that in Fig. 4, plus the print extensions with the shouldering just mentioned.

Ramming the Grid

A grid is rammed in the core with eyes for lifting it when setting it in the mold. This grid and the one in the main core are readily pulled out endwise by the casting cleaners.

The bracket at the top of the cylinder which carries the bearing for the camshaft, when cast-on as in Fig. 4, is cored out. In the pattern it is represented by a plain block print and flanking brackets. The print is of rectangular form since its core only takes out the

FIG. 8—DIESEL ENGINE CORE, CYLINDER AND LEGS MADE INTEGRAL

space between the brackets. Fig. 7 illustrates an open half mold in the Willans & Robinson foundry which gives a good idea of the method of pouring. This is done in three places, at the bottom of each leg, and at the top into a camshaft bracket. The metal enters into the feet through runners which are not visible. Being poured at three points the stream of metal does not chill, but meets and mixes in the central areas while hot. In Fig. 8 the main core is shown assembled. The halves are pasted and blackened and are lying on a core plate ready for insertion in the mold as shown in Fig. 2. The main core is inserted and one of the leg cores, which will go in the cope, is shown lying on bricks flanking the A core. The other is seen on a plate in the background. The long pins in the flask are intended to steady the alignment of the cope and drag before the cores come into contact with the mold.

In Fig. 1, which represents a mold being cored in the Sulzer foundry, at Winterthur, Switzerland, the main cores are assembled in the mold. A half core for the A portion is first inserted, on which a molder is standing in this illustration. The cylindrical body core is being lowered into its position in the top print impression and in that made in the A portion. Next the other half of the A portion will be lowered into position. One of the leg lightening cores is shown in the background.

Burning Out the Cupola Lining

By W. J. Keep

Question:—Our cupola is lined to 36 inches, but recently the lining at a point about 12 inches above the tuyeres has burned out rapidly and we have been compelled to replace it about every two weeks.

Answer:—You are the only one in a position to find out what change in your practice has brought about this result. See if you have made any change in the quality of fire brick, or in the clay used for repairs, or made a change in the tuyeres, or in the method of laying brick; the latter may have been brought about by a change of melter. If you have made no change whatever, try to make your charging more uniform. Break your scrap as small as your pig and screen all sweepings from the foundry floors or from the scaffold floor. The trouble may come from a variation in coke. In so small a cupola the blast is likely to reach the opposite lining. If the sand on the pig charged and the ash in the coke lack the proper amount of silica and alumina and you are not charging the proper quantity of lime to form slag, then the slag will cut the lining.

Cast Iron Car Wheel Difficulties

By G. S. Evans

Question:—We are casting mine car wheels, 17 inches in diameter, but are experiencing a great deal of difficulty in obtaining a chill on the rim, which also has considerable occluded slag and dirt. Our first mixture consisted of car wheel scrap entirely, but when the results were not satisfactory, we made another mixture consisting of 400 pounds of scrap rod iron; steel scrap and 600 pounds of car wheel scrap. A riser is placed on the hub and the wheels weigh 250 pounds.

Answer:—Without knowing the composition of the scrap wheels which you are using, it is difficult to advise

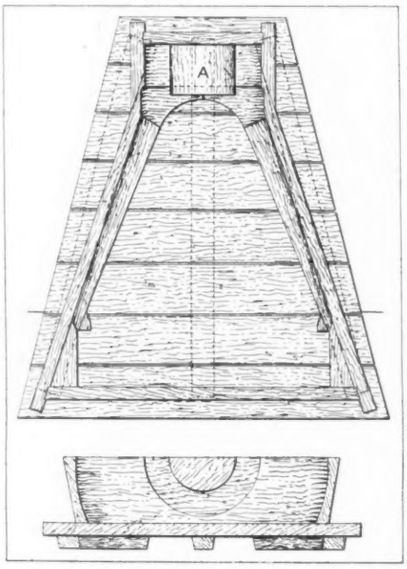


FIG. 9—BOX FOR THE A-FRAME CORE

you just what mixture would be most desirable, but assuming that these originally contained the proper analyses to give the correct chill, we suggest that you try the following mixture:

Scrap wheels, 80 per cent; scrap steel, 10 per cent and No. 3 foundry pig iron, 10 per cent. If this fails to give the required amount of chill, increase the scrap wheels to 85 per cent, reducing the No. 3 pig iron to 5 per cent; on the other hand, if the first mixture gives too much chill, reduce the scrap wheels to 75 per cent and increase the pig to 15 per cent. By changing the mixture as indicated, and to a greater extent than outlined, if this is necessary, you eventually should be able to obtain a mixture which will give you the desired results.

It is also suggested that you cast chill-test ingots, 1¼ x 3 x 6 inches, with the 1¼ x 3-inch face against a chiller, several times during the heat in order to determine the chilling capacity of the iron from different portions of the melt. Melting the iron hot and allowing it to stand a short time to permit the slag to rise to the top and to be skimmed off before pouring, will greatly reduce the slag in the finished wheels. Any dirt left in the mold or that which might wash out from the gates or cores is liable to lodge next to the chiller and this only can be overcome by careful molding practice.

Variation in Weight Allowed for Castings

Considerable confusion exists in the foundry trade relative to the percentage of weight variation allowed in gray iron, steel and malleable castings. One large factory engaged in the production of castings for electrical work is permitted an allowance of 8 per cent from the estimated drawing weight for steel motor frames and the variation allowed on cast iron is 7 per cent divided as follows: Three per cent under or 4 per cent over the estimate. The same rule applies to malleable castings except in special cases, such as motor gear castings, which are difficult to make and are subject to a considerable variation and, therefore, 12 per cent is allowed from the estimated drawing weight. In this case, however, the foundry is the loser by excess weight, as the castings are paid for by the piece. In the construction of patterns an allowance is made according to the size and style of the pattern, 1/64-inch under drawing size being allowed on certain styles and sizes of patterns, while 1/16 inch is the allowance in other cases.

Mixture for Cylinder Cores

Question:—We would like to have a good core sand mixture for air cylinder cores and jacket cores. These will be of large size and will have to be dried on end. Also, we would like to have you furnish us with a good mixture for piston cores.

Answer:—Linseed oil is used largely as a binder for these cores in the proportions of one part of linseed oil to from 30 to 35 parts of sand. A typical sand mixture follows: Old molding sand, 30 parts; new molding sand, 30 parts; sharp sand, 40 parts, and linseed oil, one part to 30 parts of the sand mixture.

The Walker M. Levett Co. is now located in its new plant at 417-421 East Twenty-third street and 422-424 East Twenty-fourth street, New York City. The new plant affords greatly increased facilities for the production of aluminum, brass and bronze castings.

THE BRASS FOUNDRY

Chemistry in the Brass Foundry---II

By E P Later

IN THE preceding article the design and equipment of a small laboratory were considered and some of the principles of qualitative and quantitative analytical chemistry were discussed briefly. While these two branches are quite distinct in some respects, in many cases they utilize the same reactions and principles, the same distinguishing characteristics of the various metals and in many other ways they are closely related; a knowledge of quantitative analysis practically demands a certain familiarity with qualitative work. Aside from this, however, it frequently happens that the presence or absence of one or two elements in an alloy, or other material, is all that need be known, or information may be required as to the general composition of a sample, with only incidental reference to the per cent of each of the elements therein. In such cases a short examination in a qualitative way may save a good deal of time and trouble and give more information than the actual estimation of one or two of the constituents. A knowledge of this subject, therefore, not only will give a much clearer insight into the mechanics of quantitative analysis, but very often will prove of value otherwise. Therefore, the general procedure and method of making the various tests will be presented as concisely as possible.

The schemes on which our present methods of qualitative analysis are based depend on the fact that all of the metals may be divided into several groups or classes, according to their behavior toward certain reagents; when these groups have been separated from each other they can be examined individually and the metals present identified by appropriate tests.

In practice, we obtain the analysis of a solution; if the sample is a solid it must be put in solution by adding a few drops of dilute hydrochloric acid; if a precipitate forms the acid should be added until no further action takes place. This precipitate will consist of the chlorides of silver, lead and mercury when the latter is present in what is known as the mercurous or lower state of oxidation. This may be explained briefly by saying that many of the elements have the power of combining in more than one proportion with some of the other elements. Thus, mercury forms two classes of compounds, in the first of which it is combined with one atom of another element, chlorine for example, the resulting salt being known as mercurous chloride or calomel; in the other it is united with two atoms of chlorine, mercuric chloride resulting, which is commonly known as corrosive sublimate. The suffixes *ic* and *ous* are used to denote compounds wherein the metal is in the higher and in the lower state of oxidation, respectively.

Properties and Characteristics

As might be expected, the *ic* and *ous* compounds of the same metal may, and generally do exhibit considerably different properties and characteristics. Refering to the solution containing the precipitated chlorides of the first group of metals, these are filtered off and washed once or twice with cold water, allowing the washings to run into the filtrate,—the solution which has run through the filter. This should then be labeled *I* and set aside for further examination.

Two or three small portions of hot water are then poured over the precipitate on the filter and collected in a clean beaker. This is done to take advantage of the fact that lead chloride is fairly soluble in hot water while the others are not, thus affording an easy means of separating them roughly. The hot water filtrate then should be separated into several small portions and tested to determine or confirm the presence of lead; the tests usually employed include adding to the first portion a little dilute sulphuric acid; if lead is present, a white precipitate will form; passing hydrogen sulphide gas through the solution, using another portion, should give a black precipitate of lead sulphide; the addition of a solution of potassium dichromate to the third portion should produce a yellow precipitate, while potassium iodide solution added to the last portion should also give a yellow precipitate.

Any precipitate remaining on the filter should be the chloride of either mercury or silver, or both, and while these would seldom be encountered in brass foundry work their separation may be given briefly for the sake of completeness. A small quantity of ammonia is poured over the precipitate and allowed to run into a clean test tube; quick blackening is evidence of mercury in the *ous* state. Any silver present is dissolved by the ammonia and passes into the test tube, where it again may be thrown down as the chloride by adding a little dilute nitric acid.

The sulphides, combinations with sulphur, of a number of metals are insoluble in water, even in the presence of a small amount of acid, a fact which is utilized in separating this group of metals from another group whose members form sulphides in alkaline or neutral, but not in acid solutions. The filtrate marked *I*, from which the lead, silver and mercury were removed, is acidified slightly with dilute hydrochloric acid, warmed and hydrogen sulphide gas passed through to saturation. If present the following metals will be precipitated as black sulphides: Lead, copper, tin, antimony, bismuth, cadmium, arsenic, molybdenum, mercury, gold, platinum, tungsten, vanadium and a number of rarer metals which need not be considered here as it is unlikely that the operator will be called upon to deal with them. As a matter of fact, several of the metals given will be found only rarely in ordinary work.

It will be noted that both lead and mercury appear also in this group. Briefly, this is because lead chloride is slightly soluble in cold water and, therefore, this metal cannot be removed entirely from solution by treatment with hydrochloric acid. In the case of the mercury it may be said that this element, when in the *ous* state comes down with the first group, but when in the *ic* state, it is found in the second group.

The solution containing the sulphides is allowed to settle for a few minutes,

then filtered and the precipitate well washed with hot water containing hydrogen sulphide and a little hydrochloric acid. It is advisable to dilute a portion of the filtrate with water and to test it with hydrogen sulphide to make sure that all of the metals of this group have been precipitated; then label it 2 and set it aside to be tested for the other groups.

A hole is punched through the filter paper and the precipitate washed into a beaker or test tube with a small amount of water; then it is warmed with a solution of sodium sulphide or ammonium sulphide, the former being preferred when mercury is absent and copper present, as will be the case in most if not all of our work. This treatment separates several of the metals from the rest of those present by virtue of the fact that the former unite with the sodium or ammonium sulphide to form soluble double sulphides, the other metals remaining in the beaker as an insoluble precipitate. It is washed with a small amount of the sulphide soultion, then with hot water.

The sulphide filtrate contains the metals of what is called the tin group, including arsenic, antimony, tin, molybdenum, gold, platinum, tungsten, vanadium and some of the rarer metals, while the insoluble material on the filter consists of the sulphides of the copper group, comprising mercury, lead, bismuth, copper, cadmium and certain other elements.

Tin Group Solution

To the solution containing the meals of the tin group, dilute hydrochloric acid is added, drop by drop, until all of the sulphides are precipitated; these are filtered off, washed, transferred to another beaker or test tube and warmed, not boiled, with strong hydrochloric acid. Dilute with a little water, filter and wash any precipitate—arsenic sulphide—which remains; ordinarily there will be none, or at most the barest traces, in the materials likely to be examined. In case anything remains on the filter, however, it is scraped off and treated with strong hydrochloric acid, with a crystal of potassium chlorate to hasten the action, until it is dissolved, then boiled to expel chlorine. Ammonia is added to alkaline reaction, turning red litmus paper blue, and the whole filtered if necessary; then ammonia, equal to one-third of the bulk of the solution, is added, followed by a mixture of magnesium chloride, ammonium chloride and ammonia. The solution is allowed to stand for several hours; a crystalline precipitate is evidence of arsenic.

The filtrate from which the arsenic was removed now contains probably only tin and antimony and may be tested for these metals by placing a few drops on a platinum foil or other platinum surface and immersing a fragment of zinc therein; a black stain will show the presence of antimony. The foil and a larger piece of zinc are then placed in the rest of the solution until all of the tin and antimony have been thrown down; they are collected by filtering, and boiled with strong hydrochloric acid, and residue filtered off and a solution of mercuric chloride added; a white precipitate will be formed if tin is present.

Use of Marsh Apparatus

Another method of procedure which is somewhat longer, but gives more delicate results, involves the use of what is known as the Marsh apparatus and depends on the fact that arsenic and antimony form gaseous compounds with hydrogen, under certain conditions; this property may be employed to distinguish these metals from tin, and, by other appropriate tests, from each other.

The Marsh apparatus consists essentially of a hydrogen generator and, if desired, the hydrogen sulphide generator described in the previous article may be made to serve, with the exception that pure, granulated zinc is used in place of ferrous sulphide. Of course, the whole outfit should be thoroughly cleaned, fresh water placed in the wash bottle and a drying tube—a U tube for example—filled with small lumps of calcium chloride and provided with rubber stoppers, each fitted with a glass tube bent at right angles and assembled so that the gas evolved passes through the wash bottle then through the drying tube, which will remove all moisture; the train ends in a hard glass tube several inches long, drawn down in a flame to a capillary at one end and at one or two places between.

In making the test the apparatus is set up and the zinc, together with a piece of platinum, placed in the generator; enough dilute hydrochloric acid is poured through the thistle tube to cause a lively evolution of hydrogen. After two or three minutes the gas may be tested to see if it contains air by inverting a test tube over the capillary tube for a few seconds, then removing it and touching a flame to the end. If the gas in the tube explodes instead of burning quietly, it shows that the hydrogen still contains air, with which it forms an explosive mixture. When the air is entirely expelled from the apparatus the hydrogen may be lighted at the end of the capillary, but before doing so it is a good idea to spread a large piece of cloth over the generator and wash bottle, to prevent glass flying about in the event of an explosion; this would not be dangerous in the ordinary sense, but might break some of the apparatus.

The hard glass tube is now heated just back of the first capillary by a bunsen flame; if no metallic mirror forms here after a few moments, pour in a little of the solution supposed to contain the tin and antimony. It should be noted whether a deposit forms in the capillary tube and whether the platinum in the generator is discolored. The gas is allowed to burn for several minutes; then the generator is cleaned out and the residue is washed by decantation; it is next boiled with strong hydrochloric acid for a few moments and then diluted somewhat and a solution of mercuric chloride added to a portion of it; a white precipitate indicates tin.

The hard glass tube is broken and the portion containing the deposit is immersed in sodium hypochlorite solution; the tin and antimony solution always contains some arsenic, if any was present in the original sample, so the deposit in the tube may be either arsenic, antimony or both. Hypochlorite solution dissolves the arsenic mirror at once, while antimony is not affected for a long time. If both these metals are present, the arsenic will deposit farther from the flame that the antimony and this portion will dissolve in the hypochlorite solution while the other will not.

Copper Group Sulphides

Going back to the copper group sulphides, these are boiled with dilute nitric acid until dissolved, adding more acid if necessary to make up for evaporation. The solution is then filtered and washed; any mercury present will remain as a black precipitate on the filter, but as this metal will hardly be found in any of the materials ordinarily encountered, a black precipitate may be undissolved sulphide of lead or other metal. Mercury may be tested for, however, by dissolving the precipitate in strong hydrochloric acid, with a few crystals of potassium chlorate, boiling to expel chlorine, and adding a little tin chloride solution; a white precipitate indicates mercury.

To the filtrate, a few cubic centimeters of strong sulphuric acid are added and it is heated in a casserole until heavy, white fumes come off, cooled and diluted with water and transferred to a beaker. A white precipitate is evidence of lead; if it forms, the solution is filtered and ammonia added to alkaline reaction. If a precipitate forms, an excess of ammonia is added, the solution heated gently and the precipitate filtered off and washed. It is dissolved by

pouring over it a little strong hydrochloric acid, evaporated to a few drops and poured into a beaker of water; a white precipitate is evidence of bismuth.

The filtrate from the bismuth may be distinctly blue, indicating copper, in which case there is usually no need of applying a confirmatory test, which may be done by acidifying a portion with acetic acid and adding a few drops of potassium ferro-cyanide solution when copper will be indicated by a red precipitate. This test is always made if the solution is colorless.

If the solution is blue, potassium cyanide is added until the blue color disappears, then hydrogen sulphide is passed in for a few moments; a yellow precipitate indicates cadmium.

To give the procedure for separating and detecting gold, platinum, molybdenum, tungsten and some of the other metals which are thrown down in this group would only prolong this article unduly and hardly would be worth while, since they are not likely to be met with in ordinary work of the character which it is intended to cover in this series.

Testing for Third Group

The filtrate marked *2*, from which the tin and copper groups were removed, is now tested for the metals of the third group—iron, chromium and aluminum; this is done by adding two or three drops of nitric acid and boiling for a moment, then adding a fairly large amount of ammonium chloride solution and an excess of ammonia. After heating nearly to boiling, the precipitate is allowed to settle, is filtered off and is washed with hot water. The filtrate is marked *3* and is set aside for further examination.

The precipitate is transferred to a casserole and is boiled for several minutes with a solution of potassium hydroxide; if there is a residue, it is filtered off and washed.

The filtrate contains any aluminum which was present, and this may be detected by acidifying slightly with hydrochloric acid and adding a solution of ammonium carbonate; a white precipitate indicates aluminum.

A portion of the residue on the filter is fused on a piece of platinum foil with a mixture of potassium nitrate and sodium carbonate; after cooling the melt is dissolved in water and filtered. The solution, or filtrate, is acidified with acetic acid and lead acetate solution added; a yellow precipitate indicates chromium.

The precipitate on the filter is dissolved in a little hydrochloric acid and tested for iron by adding a few drops of potassium sulphocyanide solution, which will produce a blood red color if iron is present.

The filtrate marked *3* is tested for the metals of the fourth group—manganese, zinc, nickel and cobalt—by passing hydrogen sulphide gas through it, or adding ammonium sulphide solution; if a precipitate appears, the solution is warmed and allowed to settle for a time, then filtered and washed with water containing a little ammonium chloride, 1 per cent. The filtrate is marked *4* and set aside.

The precipitate is treated on the filter with cold, dilute hydrochloric acid, consisting of one part strong acid to eight parts water. This solution is boiled, cooled and an excess of sodium hydroxide added; it is allowed to stand for a time and then is filtered and washed. This filtrate is tested for zinc by passing hydrogen sulphide gas through it; a white precipitate indicates zinc.

The precipitate remaining on the filter is dissolved in nitric acid, then lead peroxide and more nitric acid are added and the solution boiled; a violet coloration indicates manganese.

The precipitate remaining on the filter, after treatment with cold dilute hydrochloric acid is tested for the presence of cobalt by the borax bead, as follows: A small loop is made on the end of a platinum wire, which is then heated in a bunsen flame and dipped, while hot, into powdered borax. Upon heating again a clear, glassy bead is obtained and the process is repeated until the bead is as large as a small matchhead. The hot bead is then brought into contact with the precipitate and again heated, allowed to cool and examined. A blue color shows the presence of cobalt, but inasmuch as a large amount of nickel interferes with this test, the absence of a blue color does not necessarily mean the absence of cobalt.

Dissolving the Precipitate

In any case, the precipitate is dissolved in hot hydrochloric acid, adding a few drops of nitric acid, and the solution is boiled for a few minutes; it is finally cooled and divided into three portions.

One of these portions is evaporated to a small bulk to remove excess of acid, an excess of nitroso-B-naphthol in acetic acid solution is added and the solution filtered. Ammonia is added to the filtrate to alkaline reaction, the solution again filtered and hydrogen sulphide gas passed through the filtrate; a black precipitate is evidence of nickel.

Another portion of the solution is evaporated as before, then sodium bicarbonate is added in excess, followed by hydrogen peroxide; after warming and filtering, a green color in the filtrate indicates cobalt.

If a good color was not obtained with the borax bead, the third portion of the solution may be evaporated as before, the cobalt precipitated by adding an excess of nitroso-B-naphthol, as in the test for nickel, the solution filtered and the red precipitate again tested with the borax bead.

Ordinarily the filtrate marked *4*, from which the maganese, zinc, nickel and cobalt were removed, might contain barium, calcium, strontium or magnesium, or all of these, but only the last is at all likely to be encountered, so for the sake of clearness the separation of the others may be omitted.

A little ammonia is added and, as a precaution, a few drops of ammonium sulphate and ammonium oxalate solutions. In case a precipitate should appear it is filtered off and to the clear filtrate a solution of hydrogen disodium phosphate is added; a white precipitate indicates magnesium.

Principles Easily Applied

To any one reading it for the first time the foregoing outline, imperfect as it is, since many of the finer points and confirmatory tests in particular had to be omitted for lack of space, no doubt seems frightfully complicated and involved, but in reality the principles, and their application as well, are fairly simple when an understanding of them is once obtained. It must be remembered, too, that the separation and identification of practically all of the common metals has been given, while any alloys which the operator might be called upon to examine would probably contain only two or three metals, or at most half a dozen, which would shorten the analysis greatly as much of the manipulation would be eliminated automatically.

As a means of obtaining practice in the separation of the metals most likely to be encountered, it is suggested that solutions containing the soluble salts—nitrate, chloride or sulphate—of several or all of the following metals be made up and tested: Copper, zinc, tin, antimony, lead, iron, aluminum, bismuth. Brasses and other alloys of known composition also may be analyzed until a thorough knowledge of the procedure is obtained.

The first step in the examination of a metal is to free it from grease and dirt, then by filing or drilling obtain a small quantity of finely divided material; this should be freed from any iron particles introduced by this treatment by passing a strong magnet

through it a few times, after which it is ready to be put into solution. A small portion is treated with strong nitric acid, heating gently as long as the action continues; if necessary, the acid lost by evaporation should be replaced. Incidentally, it may be stated that a good deal of information may sometimes be obtained by observing the effect of the acid on the alloy. All of the ordinary metals except gold, platinum, tin and antimony are soluble in nitric acid, only the latter two metals being of interest to us; therefore, if the acid takes the metal completely into solution, the conclusion can be drawn that tin and antimony are not present in more than traces, and no time need be lost hunting for them, by treating the precipitated sulphides of the second group with ammonium or sodium sulphide, since only arsenic and very small quantities of antimony can be present, and they can be detected by a direct test in the Marsh apparatus.

If a white residue remains after the nitric acid treatment, the solution is diluted considerably with water and warmed to see if it dissolves. Lead nitrate is insoluble in strong nitric acid, but soluble in water, so if the residue is lead nitrate it will go into solution.

In either of the foregoing cases, as soon as a clear solution is obtained, dilute hydrochloric acid may be added to precipitate the metals of the first group and the examination carried out as given.

Dissolving the Residue

If the residue does not dissolve in warm water it is filtered off, washed and boiled for several minutes with strong hydrochloric acid, an equal amount of water added and the whole again heated to boiling, which will take up tin and antimony. Gold and platinum would not go into solution by this treatment. Especially when cold, the solution may have a milky appearance, but this may be disregarded and the two metals separated by the tests given in the foregoing. The filtrate then is subjected to the usual examination. It must be remembered, however, that the presence of much nitric acid interferes with the precipitation of the second group metals with hydrogen sulphide, so the filtrate from which the first group metals have been removed with hydrochloric acid should be evaporated to dryness, moistened with a little hydrochloric acid and again evaporated almost to dryness, in order to remove most of the nitric acid. The residue is then taken up with water and a small amount of hydrochloric acid, after which hydrogen sulphide gas may be passed through it in the usual manner.

In closing, a few words about the strength of the acids used may not be out of place as this is an important item. The term *dilute*, as used here, refers to a solution of hydrochloric acid prepared by diluting one part of strong acid with five parts of water; in the same way, one part of nitric acid is diluted with three parts of water, one part sulphuric acid with five parts of water, and so on.

Proposed Railway Equipment Alloy Standards

NON-FERROUS metals and alloys were discussed at length at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 27 to 30. Extensive revisions in the standard specifications for spelter were recommended, which consisted essentially of a change in the grading of virgin spelter by addition of the grade *Selected*, these grades now being as follows: *A*, High grade; *B*, Intermediate; *C*, Brass Special; *D*, Selected, and *E*, Prime Western.

In the former specifications it was provided that Brass Special spelter shall not contain over 0.75 per cent lead, 0.04 per cent iron and 0.75 per cent cadmium. It also was to be free from aluminum and the sum of the lead, iron and cadmium was not to exceed 1.20 per cent. This was changed as follows: Brass Special spelter shall not contain over 0.60 per cent lead, 0.03 per cent iron and 0.50 per cent cadmium, and the sum of the lead, iron and cadmium shall not exceed 1 per cent. Selected spelter shall not contain over 0.80 per cent lead, 0.04 per cent iron and 0.75 per cent cadmium. It also was to be free from aluminum and the sum of the lead, iron and cadmium shall not exceed 1.25 per cent. The previous specifications for Prime Western spelter provided that it shall not contain over 1.50 per cent lead and 0.08 per cent iron, whereas the revision decreases the percentage of iron to 0.06, the percentage of lead remaining unchanged.

The section referring to sampling was stricken out and the following substituted: "Select 10 slabs at random from a car load and saw each slab completely across from the middle of one long side to the middle of the other and use the sawdust as the sample; or, drill three 9 mm. holes along one diagonal of each slab, boring completely through, and taking care to make fine drillings; the holes should be drilled as nearly as possible at the middle and half way between either end and the middle of such diagonals. Go over the drillings or sawings with a powerful magnet to take out any iron which may have come from the drill or saw, and mix the sample thoroughly. The drill or saw must be thoroughly cleaned before use, and no lubricant shall be used in either drilling or sawing."

Section 7 of the former specification on analysis was substituted by one which provides for both electrolytic and lead acid methods of analyses.

W. M. Corse, chairman of the subcommittee on sand cast metals and alloys, reported that data had been collected on various types of alloys and a study is being made of the relation between elastic limit and yield point as well as the behavior under compression. Tentative specifications also were presented for copper plates, locomotive fireboxes, copper bars, locomotive staybolts and seamless copper boiler tubes.

G. H. Clamer, chairman of the subcommittee on non-ferrous alloys for railroad equipment, presented proposed tentative specifications on which criticisms are solicited and should be directed, preferably before Jan. 1, 1917, to William Campbell, Columbia University, New York City. These proposed tentative specifications follow:

1—(*a*) These specifications cover the various non-ferrous alloys for locomotive equipment in ingots, castings and finished car and tender bearings.

(*b*) These alloys and the purposes for which they are frequently used are as follows:

Bearing Metal Nos. 1 and 2 for connection-rod bearings, bushings, eccentric straps, driving-box bearings, trailer-truck bearings, cross-head gibs, hub liners and miscellaneous bushings.

Bearing Metals Nos. 3 and 4 for lead-lined bearings, for locomotive tenders, freight and passenger car equipment.

Bell Metal for locomotive bells only.

Steam Metal for cocks, valves, water gage and gage valves, injectors and other castings subjected to internal steam pressure.

Red Brass for miscellaneous castings for which a red color is desirable and which are not intended to resist internal pressures.

Yellow Brass for car trimmings.

Brazing Metal for fittings and unions for copper pipe.

Babbitt Metal for babbitting driving boxes, rod brasses, crossheads and for hub liners.

Lining Metal for lining truck brasses, tender brasses and car brasses.

CHEMICAL PROPERTIES AND TESTS.

2—(*a*) The alloys shall conform to the requirements as to chemical composition, with the permissible variations specified in the accompanying table.

(*b*) Where no figures are given for impurity maximum, these elements may be present up to any amount to come within the total impurity specified, providing the material

otherwise meets the chemical and physical tests. Where maximum percentages are specified, the elements referred to are considered as impurities and shall not be intentionally added.

3—An analysis will be made by the purchaser or his representative from one ingot, casting or journal bearing representing each lot. The chemical composition thus determined shall conform to the requirements specified in Section 2 for the particular alloy.

4—(*a*) *Ingots.*—Drillings shall be taken with a drill at least ½ inch in diameter at a point midway between the heaviest and smallest cross-section of the ingot. Ingots having two or more sections, drillings to be taken from each section. In the case of babbitt metal and lining metal, drillings so taken shall be melted in a thoroughly cleaned ladle with a little rosin flux and poured into a piece of thin section. This piece shall be sawed into three parts and the sawings therefrom thoroughly mixed to constitute a sample for chemical analysis.

(*b*) *Locomotive Castings.*—Drillings shall be taken with a drill as large as possible at such points in the casting as shall be thoroughly representative. Drillings through the skin shall be rejected. Drillings thoroughly mixed shall constitute the sample for chemical analysis.

(*c*) *Car and Tender Bearings.* — Drillings shall be taken with a drill at least ½ inch in diameter, at three points on the bearing selected for the physical test as specified in Section 5 (*b*), as widely separated as possible. Drillings representing the skin of the casting shall be rejected. These drillings, thoroughly mixed, shall constitute the sample for chemical analysis.

Drillings shall be taken in a like manner from the lining, exercising care that the drill does not penetrate the soldered surface.

(*d*) All samples, whether taken with a drill or saw, to be kept free of oil and to be magnetized to remove iron introduced in taking the sample.

PHYSICAL INSPECTION AND TESTS

5—(*a*) *Locomotive Castings.*—The castings shall be sound, free from blowholes, flaws or shrinkage cracks, and shall show good foundry practice and workmanship.

One casting representing each lot of locomotive bearings will be broken by the purchaser or his representative, for examination of fracture. The fracture shall disclose no shrink discoloration, segregation, dross or dirt spots within ⅝ inch of the bored journal engaging surface, and shall show no distinct signs of imperfect mixture.

(*b*) *Car and Tender Bearings.*—The bearings shall be sound, free from sand, blowholes, flaws or shrinkage cracks, and shall show good foundry practice and workmanship.

One bearing representing each lot will be broken by the purchaser or his representative for examination of fracture. The fracture shall show no shrink discoloration, segregation, dross or dirt spots within ½ inch of the bored journal engaging surface. This test shall be made before linings are applied. A second test shall be made after application of the lining as follows:

(1) The suspended brass, when tapped with a hammer, shall give a distinct ring.

(2) The lining, when chipped with a cold chisel, shall tear from the soldered surface as distinguished from clean shearing.

6—(*a*) *The Ingot.*—Each 5,000 pounds or fraction thereof shall constiute a lot. The ingot from which the sample is taken to be included in the shipment.

(*b*) *Locomotive Castings.*—Each 100 castings or fraction thereof unless otherwise specified shall constitute a lot.

The manufacturer shall furnish, free of cost, one casting representing each lot for the purpose of tests as specified in Sections 4 (*b*) and 5 (*a*).

(*c*) *Car and Tender Bearings.*—Each 300 bearings or fraction thereof, unless otherwise specified, from each pattern shall constitute a lot.

The manufacturer shall furnish, free of cost, one bearing representing each lot for purposes of tests as specified in Sections 4 (*c*) and 5 (*b*).

PERMISSIBLE VARIATIONS IN DIMENSIONS

(*For Car and Tender Bearings Only.*)

7—(*a*) The purchaser will furnish drawings showing the dimensions of the bearings ordered and permissible variations therefrom and the bearings shall conform to these drawings within such permissible variations.

(*b*) The thickness at the center of the brass and of the complete bearing shall not vary more than $\frac{1}{64}$ inch over or under the normal thickness shown on the drawing. The thickness of the lining shall not vary more than $\frac{1}{32}$ inch over or under the normal thickness shown on the drawing.

WORKMANSHIP

8—(*a*) *Locomotive Castings.* — The castings shall conform to the dimensions specified and shall show good workmanship generally.

(*b*) *Car and Tender Bearings.*—The bearings shall show good workmanship generally, and shall be free from mechanical imperfections. They shall be bored to a true radius, and with the axis parallel to the plane of the top and perpendicular to the side lugs and bearing flange. The lettering shall be clear and distinct. No emery to be used on journal engaging surfaces on either the brass or the lining.

9—(*a*) *Ingot.*—The manufacturer's marking only shall be required, unless otherwise specified.

(*b*) *Locomotive Castings.*—The lot number and other marks as required by the drawings shall be legibly marked on each casting.

(*c*) *Car and Tender Bearings.*—The name or initials of the manufacturer, the initials of the purchaser, type number, journal size, and lot number shall be legibly cast with raised figures on a depressed surface of each bearing, as shown on drawings.

INSPECTION AND REJECTION

10—(*a*) Inspection may be made at the manufacturer's works where the ingots, locomotive castings or car and tender bearings are made, or at the point at which they are received, at the option of the purchaser.

(*b*) If the purchaser elects to have inspection made at the manufacturer's works, the inspector representing the purchaser shall have free entry at all times while work on the contract is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

11.—Failure to meet the chemical or physical specifications, or non-conformity to any of the foregoing requirements as to permissible variations, dimensions and markings, constitute sufficient cause for rejection of the lot represented by the sample chosen.

Non-Ferrous Metal Mixtures

Alloy	Copper, per cent.	Tin, per cent.	Lead, per cent.	Zinc, per cent.	Iron, max., per cent.	Antimony, per cent.	Phosphorus, max., per cent.	Aluminum, per cent.	Sulphur, max., per cent.	Total Impurity including zinc, per cent.
Bearing Metal No. 1.	remainder	9-11	9-11	1.5*a*	0.4	0.5*a*	....	none	....	1.0
Bearing Metal No. 2.	remainder	7-9	14-16	1.5*a*	0.4	0.5*a*	....	none	....	1.0
Bearing Metal No. 3.	remainder	7-9	14-16	3.0*a*	0.4	0.5*a*	....	none	....	1.0
Bearing Metal No. 4.	remainder	4-6	15-20	5.0*a*	0.4	0.5*a*	....	none	....	1.0
Bell Metal	remainder	16-18	0.25*a*	0.25*a*	0.25	0.25*a*	0.02	none	0.05	0.5
Steam Metal	remainder	5-7	2-3.5	3-5*a*	0.25	0.25*a*	0.02	none	0.05	0.5
Red Brass	remainder	4-6	4-6	4-6	0.40	0.40*a*	0.02	none	0.05	1.0
Yellow Brass	remainder	1.5*a*	1-3	29-33	0.50	0.50*a*	....	none	....	1.25
Brazing Metal	remainder	0.5*a*	0.5*a*	18-22	0.40	0.25*a*	....	none	....	1.0
Babbitt Metal	0.5*a*	9-11	remainder	0.10*a*	0.05	15-17	....	none	....	0.75
Lining Metal	0.5*a*	4-6	remainder	0.10*a*	0.05	9-11	....	none	....	0.75

*a*Maximum.

The report of the committee on cast iron and finished castings was presented by Dr. Richard Moldenke, chairman. During the year the sub-committee on car wheels has been engaged in revising the standard specifications for cast iron wheels, two meetings having been held, but since the work is not completed, no report will be made until next year. The committee reported a general demand for specifications for cast iron soil pipe and fittings. Manufacturers and consumers are realizing that there are too many minor variations in a product which should be as much subject to standardization as the material for water distribution systems. Tentative specifications already have been drawn which have been circulated among the members of the committee competent to pass upon them, but no report will be submitted until next year.

The present tentative specifications for foundry coke were referred to letter ballot of the society for adoption as a standard, and proposed tentative methods for sampling and analysis of coke were submitted for printing in the 1916 year book as an addendum to the standard specifications.

Lead Production in 1915

According to statistics compiled by the United States Geological Survey, the production of primary refined lead in the United States in 1915 totaled 550,055 tons with a value of $51,705,000, as compared with 542,122 tons with a value of $42,286,000 in 1914.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Melting Tobin Bronze Turnings

We have a large accumulation of turnings and borings which we would like to remelt for casting purposes. These consist of Tobin bronze, government bronze, 88-10-2, phosphor bronze and other material. The castings which we would like to make have no special requirements other than that they should be easily machined. Would the addition of phosphor-tin or phosphor-copper help this metal? The mixture is to be melted in an oil-fired furnace. So far as we can ascertain, the turnings contain very little iron.

Tobin bronze turnings should be kept separate from other grades of bronze, since this mixture contains about 39 per cent of zinc, which would affect the turnings of phosphor and government bronzes. With these exceptions, the turnings could be melted to form one mixture, and it should not be necessary either to add phosphor-tin or phosphor-copper, since phosphor bronze constitutes one part of the turnings and too much phosphorus would prove injurious to the casting properties of the alloy. No difficulty should be experienced in making satisfactory castings from a mixture melted in an oil-fired furnace. Not to exceed 10 per cent of the Tobin bronze can be used with the other turnings, and if they are in considerable quantity, they will have to be used alone, but no particular difficulties should be experienced in casting.

The Rotation of Metals in Melting

We would like to know how to combine metals having different fusing points; for example, tin, copper, lead and antimony. To combine these metals to obtain a uniform mixture, which should be melted first and in what order should they be melted to secure the best results?

The best method is to melt the most refractory metal first, adding the others in rotation in the order of their melting temperatures, but when the melting point of the most refractory metal is beyond the heating capacity of the furnace, it may be melted with one of the more fusible metals. This practice usually is pursued in melting nickel and copper alloys. It is exceedingly difficult to melt the nickel alone, and in addition, it will absorb carbon, but if the nickel is charged with the copper, both metals can be melted readily. The same applies to the melting of copper and silicon, copper and titanium, etc. When making babbitt metals the copper is melted in a crucible furnace followed by antimony, and then a sufficient amount of tin is added to form an alloy of copper, antimony and tin, that will melt or dissolve in the bath of molten tin in the babbitt kettle. Another method consists of melting the copper and the antimony, removing the crucible from the fire and pouring the molten mixture into the molten tin which previously has been melted in the kettle; or, sometimes, the entire alloy is made in a crucible, in which case the tin is added to the molten copper-antimony alloy.

Sand-Burnt Brass Castings

We are making brass and bronze castings, but we are experiencing a great deal of trouble due to the burning of the sand onto the metal. Can you tell us how to produce clean, smooth castings?

If the castings are heavy, coat the mold with a good grade of plumbago, brushed on and afterwards slicked, and also blackwash the cores. If the castings are small, the metal is being poured too hot or contains phosphorus and the remedy is to pour cooler. The production of clean, smooth castings is dependent upon the grade of sand used in molding, the kind of metal employed, the pouring temperature, as well as the skill of the molders. The sand should be fine, but not too close; the metal should be a good grade of red brass containing no phosphorus, and the temperature at which the metal enters the mold must be kept below the boiling point of the molten mass unless the castings are very thin, and the molds must be properly rammed, gated and poured.

A Bushing Mixture for Motor Cars

We would like to have a good mixture for small bushings for light automobiles.

A mixture that can be recommended follows: Copper, 80 per cent; tin, 10 per cent and lead, 10 per cent.

Brass Discoloration Due to Iron

We have a supply of composition ingot metal on hand which contains about 1.75 per cent of iron. This will not affect our alloy in any way except the color. We would like to know what addition should be made to the alloy to offset the black color imparted by the iron. The mixture contains 68 per cent copper, 4 per cent lead, 1 per cent tin and the balance zinc and iron. What effect will the addition of antimony have on the color?

Since the alloy contains more than 25 per cent of zinc, it is a yellow brass with the lead content rather high. The iron should not affect the alloy, since many yellow brasses, such as Sterro metal, Delta metal, Arch metal, etc., contain iron which is added to improve the mechanical properties of the alloy. The iron contained in the ingots, of course, can be cut down by the addition of new metal, employing half new metal and half ingots, or any other proportion found to be convenient, but there is nothing that can be added to the alloy in its present form that will eliminate discoloration due to the iron. The addition of antimony would be unwise, since it would ruin the alloy by imparting brittleness. It is more advisable to convert the metal into some other alloy, using it for its zinc content rather than to attempt to add something to it other than a small percentage of zinc or a few hundredths of 1 per cent of aluminum.

Brass Piston Difficulties

We are experiencing considerable difficulty in obtaining sound castings of a brass piston 2½ feet long, the metal thickness being ⅜ inch and which has a 5-inch core. It is flanged on one end 9 inches across, the flanges being 1 inch in thickness and has also five strengthening pieces. Some of these were gated at the bottom, while others were gated half way the length of the mold. All of the castings were porous. Our mixture consists of yellow brass scrap to which 1½ per cent of phosphor-copper is added. Some of these pistons were poured hot, while others were poured cold. Those which were poured with dull metal did not run while the castings poured with the hot metal were spongy and full of blow-holes. Many of

these pistons were made satisfactorily before, but they were cast flat and we would like to know the best method of gating and the proper mixture to employ.

The fact that the castings are porous indicates that the metal is at fault and we suggest that the use of phosphor-copper be discontinued and 0.5 per cent of manganese-copper be substituted therefor. If the addition of manganese slows up the metal to the extent of preventing the running of the castings, add 0.25 per cent of phosphor-copper to correct this difficulty. If the porosity persists after the foregoing treatment, the scrap contains so much dissolved oxide that it is hopeless to attempt to use it for such castings and new metals should be tried. With reference to molding, it is our opinion that the horizontal method is to be prefered. A casting ⅜-inch thick and 30 inches long probably requires more than one gate and it should be poured on an incline. If molded upright the flange should be at the bottom and not at the top as otherwise there is a tendency for the flange to hang and the long cylindrical body shrinks away therefrom. The castings should be gated at the bottom on the rim of the flange and it would be a good idea to place supplementary gates in the mold at a point about half way the length of the casting.

Aluminum Mixtures for Crank Cases

We would like to have a good aluminum alloy for crank cases for aeroplane motors.

An excellent alloy for this purpose consists of the following: Aluminum, 93 per cent, and copper, 7 per cent. To prepare the alloy a hardener first should be made containing 50 per cent copper and 50 per cent aluminum, and 14 per cent of this hardener is added to 86 per cent of aluminum. By increasing or decreasing the proportions of the hardener, the resulting alloy can be made harder or softer, as desired.

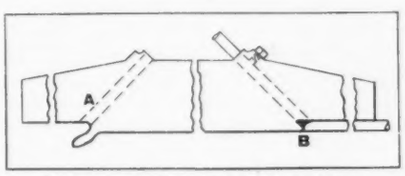
Melting Copper Bands From Shrapnel Shells

We would like to know if the copper bands from shrapnel shells can be used for casting purposes? If so, we would be pleased to have you give us directions for casting them.

The copper used in rotating bands for shells is satisfactory for casting purposes and can be employed for making any alloy such as brass, bronze or composition. Most of these bands are made from rolled stock, which is pure copper, although some also are being cast in sand in the form of rings which subsequently are rolled. The copper, however, is quite pure, being melted in an open-flame furnace and after poling, a small percentage of silicon-copper or vanadium-aluminum is added. The scrap bands should be flattened, when they can be charged into the crucible the same as any other copper. A cover of fine charcoal always should be used on the surface of the molten copper, and it also is advisable to use a good flux that will form a liquid slag.

A Mixture for Trolley Wire Connections

We would like to obtain the formula of a mixture for a trolley wire connection, as shown in the accompanying illustration. We have been making these with a large percentage of copper to enable us to bend the projection, A, to make a smooth joint as shown at B. Sample connections which we have obtained from another plant seem to contain a much lower percentage of copper than the ones we are making. What price should be charged a regular consumer for a mixture containing copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent, cast in the form of bushings, bearings, etc., and weighing from 10 to 100 pounds? Also, what price should be charged for the trolley connections referred to, in lots of 100 and over?



BRASS DEVICE FOR SPLICING TROLLEY WIRE

An excellent mixture for trolley ears follows: Copper, 87 per cent; zinc, 8 per cent; tin, 2 per cent, and lead, 3 per cent. Possibly this alloy would be found sufficiently stiff for the splicer illustrated, but if not, the following mixture will be satisfactory: Copper, 88 per cent; tin, 6 per cent; zinc 3.5 per cent, and lead, 2.5 per cent.

The price of brass castings is based on the cost of metals, plus the cost of manufacture, plus the profit generally figured in brass foundry operations. For the 88-10-2 mixture estimate a price based on the prevailing market for these metals, and, in addition, add the cost of molding, melting and melting losses, etc., in which should be included the usual profit. A differential of 9 cents per pound would not be too great for the castings mentioned, while for trolley ears several cents additional should be charged, since they are light and contain cores. If scrap metals are used, castings, of course, can be made at a lower price than when new metals are employed. On the other hand, if you buy the scrap at a low price and the market advances later, you should take advantage of this foresight on your part and charge the consumer a price based on prevailing quotations for scrap metals. At the present time it is hardly safe to estimate the selling price of brass castings at less than 10 cents per pound above the price of new metals, although recently some quotations have been made at from 2 to 3 cents above the cost of the new metals. However, in these instances, the manufacturers figure on using scrap.

Natural or Forced Draft Furnace?

We are contemplating the erection of a new furnace which will have a capacity for a crucible 14 inches in diameter and 17 inches deep. Kindly let us know whether this furnace should be of the natural or forced draft type?

The decision as to whether natural draft or blast-driven furnaces should be employed depends entirely upon circumstances. If the furnace can be attached readily to a stack that will produce a good draft, a natural draft furnace will be cheaper to install and operate and will be found to be satisfactory. However, if a stack has to be built, the expense involved in its erection will depend upon its location. If the foundry is in a congested district, the stack will have to be of sufficient height to extend above the tops of all of the adjoining buildings and the expense therefore will be considerable. However, if the shop is located in an outlying district, a short stack will meet all requirements, a height of 40 feet being employed. A natural draft furnace is cheaper to operate, since no power is required to furnish the blast. A natural draft furnace is to be preferred from the standpoint of the comfort of the workmen, since the escape of gas is entirely avoided. On the other hand, if the grate and flue areas are not properly proportioned, natural draft furnaces are unsatisfactory, while with forced draft furnaces these factors are not of such great importance. On the other hand, the forced draft furnace is more certain of results, will melt more quickly, but is more expensive in cost of operation. However, the latter is only of minor consideration if the output is large.

White Brass Mixtures

We would like to have two good mixtures for white brass, one to be used as a bearing on dynamos and one for the general run of shop castings.

Try the following mixtures:

Bearings: Tin, 64 per cent; zinc, 34 per cent, and copper, 2 per cent.

For the general run of shop castings use tin, 60 per cent; zinc, 38 per cent and antimony, 2 per cent.

Foundrymen Prepare for Cleveland Convention

Many Manufacturers Have Reserved Space for Exhibits in Coliseum—List of Papers to be Read During Foundrymen's Week

THAT the exhibition of foundry equipment and accessories, machine tools, etc., to be held at Cleveland during the week of Sept. 11, concurrent with the annual meetings of the American Foundrymen's Association and the American Institute of Metals, will surpass in magnitude any similar undertaking, is indicated by the large number of manufacturers who already have made reservation. Fully 90 per cent of the exhibit space in the Coliseum has been disposed of, and since 10,000 additional square feet will be required to meet the needs of prospective exhibitors, it has been decided to erect a temporary building on a lot directly across the street from the exhibition hall. At a meeting of the exhibition committee of the American Foundrymen's Association, held at the Hotel Statler, Cleveland, on Saturday, June 24, the erection of this annex was authorized.

The two buildings will be connected by a runway, making it unnecessary for the visitors to descend to the street when passing from one to the other. It is planned to place all of the large operating machines requiring heavy foundations in the temporary structure, and it is probable that several different types of melting furnaces will be shown in operation. The annex will be converted into a temporary foundry where molds will be made and poured. Since the Coliseum was erected, many shows have been held in it. It affords 60,000 square feet of floor space, but this industrial exhibition will be the first to overflow its generous dimensions, making necessary the erection of a temporary annex to provide space for all of the manufacturers who contemplate making exhibits. The exhibit will be the biggest and most complete show of its kind ever held in Cleveland, and the local interest now manifested points to an unusually large representation of Cleveland products.

Although more than two months still intervene before the opening of the exhibition, 95 manufacturers already have made reservations and the indications are that this total will be swelled to 150 when the doors of the Coliseum and the annex are thrown open on Monday, Sept. 11. At Atlantic City last year there were 102 exhibitors and never before in the history of this exhibition movement has so much space been reserved so far in advance of the opening of the show as this year. The complete list of manufacturers who have made application for space, up to June 24, accompanies this announcement.

The papers and committee reports to be presented at the annual meeting of the American Foundrymen's Association promise an unusually valuable and interesting program. Separate sessions will be held for the discussion of topics relating to the manufacture of gray iron, steel and malleable castings. The opening meeting will be held at the Hotel Statler, Monday afternoon, Sept. 11. It will be followed by morning sessions only, the convention closing Friday, Sept. 15. This arrangement will afford the foundrymen more opportunity to inspect the exhibits than has been the case in former years with two sessions daily, although the length of the program will necessitate several simultaneous meetings.

Three symposiums will feature the program, the subjects of which follow: "The Results of Closer Co-

Partial List of Exhibitors at Cleveland

American Gum Products Co., New York.
Arcade Mfg. Co., Freeport, Ill.
Armstrong Cork Co., Pittsburgh.
Atkins, E. C., & Co., Indianapolis.
Ayer & Lord Tie Co., Chicago.
B. & B. Mfg. Co., Indianapolis.
Berkshire Mfg. Co., Cleveland.
Besly, Chas. H., & Co., Chicago.
Birkenstein, S., & Sons, Chicago.
Blystone Mfg. Co., Cambridge Springs, Pa.
Brown Specialty Machinery Co., Chicago.
Carborundum Co., Niagara Falls, N. Y.
Cataract Refining & Mfg. Co., Buffalo.
Chicago Pneumatic Tool Co., Chicago.
Cleveland Blow Pipe & Mfg. Co., Cleveland.
Cleveland Pneumatic Tool Co., Cleveland.
Coale, Thomas E., Lumber Co., Philadelphia.
Curtis Pneumatic Machinery Co., St. Louis.
Daily Iron Trade, Cleveland.
Davis-Bournonville Co., Jersey City, N. J.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Excelsior Tool & Machine Co., East St. Louis, Ill.
Federal Foundry Supply Co., Cleveland.
Felt & Tarrant Mfg. Co., Chicago.
Foundry, The, Cleveland.
Gardner Machine Co., Beloit, Wis.
General Electric Co., Schenectady, N. Y.
Gibb Instrument Co., Pittsburgh.
Gisholt Machine Co., Madison, Wis.
Goldschmidt Thermit Co., New York.
Graceton Coke Co., Graceton, Pa.
Great Western Mfg. Co., Leavenworth, Kans.
Hardy, F. A., & Co., Chicago.
Harris, Benjamin, & Co., Chicago.
Herman Pneumatic Machine Co., Pittsburgh.
Herold Bros. Co., Cleveland.
Hill-Brunner Foundry Supply Co., Cincinnati.
Hoevel Mfg. Corporation, New York.
Ingersoll-Rand Co., New York.
Iron Trade Review, Cleveland.
Jennison-Wright Co., Toledo.
King, Julius, Optical Co., New York.
Lehigh Coke Co., South Bethlehem, Pa.
Lincoln Electric Co., Cleveland.
Lupton's, David, Sons Co., Philadelphia.
McCormick, J. S., Co., Pittsburgh.
Macleod Co., Cincinnati.
Mahr Mfg. Co., Minneapolis.
Malleable Iron Fittings Co., Branford, Conn.
Manitowoc Electric Implement Co., Manitowoc, Wis.
Midland Machine Co., Detroit.
Moldar Co. (Richey, Browne & Donald), Maspeth, N. Y.
Moltrup Steel Products Co., Beaver Falls, Pa.
Monarch Engineering & Mfg. Co., Baltimore.
Motch & Merryweather Machinery Co., Cleveland.
Mott Sand Blast Mfg. Co., Chicago.
Mumford, E. H., & Co., Elizabeth, N. J.
National Engineering Co., Chicago.
New Haven Sand Blast Co., New Haven, Conn.
Norma Co. of America, New York.
Norton Co., Worcester, Mass.
Obermayer, S., Co., Chicago.
Oliver Machinery Co., Grand Rapids, Mich.
Osborn Mfg. Co., Cleveland.
Oxweld Acetylene Co., Chicago.
Pangborn Corporation, Hagerstown, Md.
Penton Publishing Co., Cleveland.
Pickands, Brown & Co., Chicago.
Portage Silica Co., Youngstown, O.
Pyrotectic Co., Chicago.
Pyrotectic Co., Chicago.
Robeson Process Co., New York.
Rogers, Brown & Co., Cincinnati.
Sand Mixing Machine Co., New York.
Sly, W. W., Mfg. Co., Cleveland.
Smith Facing & Supply Co., Cleveland.
Smith, R. P., & Sons Co., Chicago.
Smith, Werner G., Co., Cleveland.
Snyder Electric Furnace Co., Chicago.
Standard Sand & Machine Co., Cleveland.
Sterling Wheelbarrow Co., West Allis, Wis.
Stevens, Frederic B., Detroit.
Strong, Kennard & Nutt Co., Cleveland.
Sullivan Machinery Co., Chicago.
Superior Sand Co., Cleveland.
Thomas Elevator Co., Chicago.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
Union Steam Pump Co., Battle Creek, Mich.
U. S. Graphite Co., Saginaw, Mich.
U. S. Molding Machine Co., Cleveland.
Wallace, J. D., Chicago.
Warner & Swasey Co., Cleveland.
White & Bro., Philadelphia.
Whiting Foundry Equipment Co., Harvey, Ill.
Woodison, E. J., Co., Detroit.

operation Between the Engineer and the Foundry as Relating to Gray and Malleable Iron, Steel and Non-Ferrous Metals"; "The Influence of Gating on Castings, Including Gray and Malleable Iron, Steel and Non-Ferrous Metals", and "Electric Furnace Practice as Relating to the Production of Steel Castings". Four authors will present papers for each of these symposiums, and every phase of these respective subjects will be discussed. Several interesting papers on "Sand Reclamation", also will be presented, covering investigations made among all of the members of the American Foundrymen's Association and by the United States Bureau of Standards. A partial list of papers already promised and the names of their authors is presented above on this page. To provide for the entertainment of the visiting foundrymen and to direct them in plant visitation, local committees have been organized, the chairman of which held their first meeting at the Hotel Statler, Cleveland, on Saturday, June 24. F. B. Whitlock, Interstate Foundry Co., has been appointed chairman of the general directing committee which consists of the chairmen of the other committees.

Papers to be Read During Foundrymen's Week

"Sand Reclamation," by H. B. Swan, Cadillac Motor Car Co., Detroit.

"Progress Report on Sand Reclamation," by C. P. Karr, associate physicist, U. S. Bureau of Standards, Washington, D. C.

Symposium on "The Results of Closer Co-operation Between the Engineer and the Foundry," as relating to

- "Gray Iron," by O. W. Sowers, Sowers Mfg. Co., Buffalo.
- "Steel," by John Howe Hall, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
- "Malleable Iron," (author not yet determined.)
- "Non-Ferrous Metals," by C. E. Chase, Modjeski & Angier, Chicago.

Symposium of "The Influence of Gating on Castings," including

- "Gray Iron," by B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
- "Steel," by William Gilmore, Hubbard Steel Foundry Co., East Chicago, Ind.
- "Malleable Iron," by A. M. Fulton, Fort Pitt Malleable Iron Co., Pittsburgh.
- "Non-Ferrous Metals," by R. R. Clarke, Pennsylvania Railroad Co., Pittsburgh.

"The Significance of the Fire Waste," by Franklin H. Wentworth, secretary, National Fire Protective Association, Boston.

"Profit Sharing in the Jobbing Foundry," by C. E. Knoeppel, New York City.

"What the Pratt Institute Has Done, Is Doing and Hopes to Do, in the Training of Men for the Foundry Industry," by Samuel S. Edmands, Pratt Institute, Brooklyn.

"The Installation of Uniform Cost Systems by Members of Technical Societies," by Clinton H. Scovell, Clinton H. Scovell & Co., Boston.

"Report of Committee on Standard Specifications for Foundry Scrap," by G. E. Jones, chairman, Whiting Foundry Equipment Co., Harvey, Ill.

"Report of the Committee Advisory to the U. S. Bureau of Standards," by Richard Moldenke, chairman, Watchung, N. J.

"Report of the Committee on Safety and Sanitation," by Victor T. Noonan, chairman, Industrial Commission of Ohio, Columbus.

"Report of Representatives on the Conference Board on Training of Apprentices," by B. D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland.

Gray Iron Session.

"The Effect of Different Mixtures on the Strength of Chilled Car Wheels," by G. S. Evans, Lenoir Car Works, Lenoir City, Tenn.

"The Manufacture of Semi-Steel Castings," by David McLain, McLain's System, Milwaukee.

"The Use of By-Product Coke in Foundry Operations," by George Long, Pickands, Brown & Co., Chicago.

"How Certain Cleaning Room Problems Have Been Solved," by H. Cole Estep, *The Foundry*, Cleveland.

"The Use of Borings in Cupola Operations," by James A. Murphy, Hooven, Owens & Rentschler Co., Hamilton, O.

"One-Third of a Century in a Gray Iron Foundry," by Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.

"The Introduction of Molding Machines in Foundries," by A. O. Backert, Penton Publishing Co., Cleveland.

"The Experimental Foundry," by H. K. Hathaway, Tabor Mfg. Co., Philadelphia.

"Report of Committee on Standard Specifications for Foundry Scrap," by G. E. Jones, chairman, Whiting Foundry Equipment Co., Harvey, Ill.

"Report of Committee on Standard Methods for Coke Analysis," by H. E. Diller, chairman, General Electric Co., Erie, Pa.

"Report of Committee on General Specifications for Gray Iron Castings," by W. P. Putnam, chairman, Detroit Testing Laboratories, Detroit.

Steel Session

Symposium on "Electric Furnace Practice for the Manufacture of Steel Castings,"

- F. T. Snyder, Snyder Electric Furnace Co., Chicago.
- A. B. Clarke, Buchanan Electric Steel Co., Buchanan, Mich.
- John A. Crowley, John A. Crowley Co., New York.
- "Making Electric Steel in the Rennerfelt Flaming Arc Furnace for Foundry Purposes," by C. H. Vom Baur, Hamilton & Hansell, New York.

"Crucible and Electric Steel, Compared," by T. S. Quinn, Lebanon Steel Foundry, Lebanon, Pa.

"Converter and Electric Steel for Casting Purposes, Compared," by Peter Blackwood, Monarch Steel Casting Co., Detroit.

"Manganese Steel Castings," by W. S. McKee, American Manganese Steel Co., Chicago.

"Titanium in Steel Castings," by W. A. Janssen, Bettendorf Co., Davenport, Ia.

"Report of Committee on Steel Foundry Standards," by Dudley Shoemaker, chairman, Atlantic Steel Casting Co., Chester, Pa.

"Report of Committee on Specifications for Steel Castings," by John Howe Hall, chairman, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

"The Small Open-Hearth as a Flexible Unit for Either Large Steel Foundries or General Jobbing Shops," by Frank Carter, Milwaukee.

"The Presence of Alumina in Steel," by G. F. Comstock, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

"The Particular Application of Green Sand Molding in the Steel Foundry," by A. F. S. Blackwood, Monarch Steel Casting Co., Detroit.

"Theory and Practice of Heading and Gating Steel Castings," by Ralph H. West, West Steel Casting Co., Cleveland.

"Acid versus Basic Steel for Making Castings," by E. F. Cone, *The Iron Age*, New York.

"Alloy Steel Castings," by David Evans, Chicago Steel Foundry Co., Chicago.

Malleable Iron Session

"The Application of Malleable Iron Castings in Car Construction," by Frank J. Lanahan, Fort Pitt Malleable Iron Co., Pittsburgh.

"Commercial Side of the Malleable Iron Industry," by W. G. Kranz, National Malleable Castings Co., Cleveland.

"Report of Committee on Specifications for Malleable Iron Castings," by Enrique Touceda, chairman, Albany, N. Y.

Papers will be presented on various subjects relating to malleable iron practice, by the following authors:

- Edwin F. Leigh, Marion Malleable Iron Works, Marion, Ind.
- S. H. Standish, Northwestern Malleable Iron Co., Milwaukee.
- G. Meehan, Ross-Meehan Foundry Co., Chattanooga, Tenn.
- Enrique Touceda, consulting engineer, Albany, N. Y.
- W. A. Forbes, Rockford Malleable Iron Works, Rockford, Ill.
- A. H. Chapelka, Chisholm & Moore Mfg. Co., Cleveland.

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A monthly journal devoted to all branches of the foundry trade

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Stop, Look and Listen

OCCASIONALLY it is advisable to put on the brakes to see where we are headed. Nothing will be lost and everything is to be gained by heeding the warning of "stop, look and listen". This applies particularly to labor conditions prevailing in our foundries, and while labor may be having its inning today and is reaping the harvest of these abnormal times, it is well to inquire what the future has in store. No longer is it a question of closed or open shop, the problem only involving the means of the casting manufacturer to meet the demands of labor in wages, hours and working conditions. Dissatisfaction, bred by a feeling of unrest and fostered by a shortage of unskilled men, is stalking unbridled among the working forces of American foundries, and the amount paid for a day's labor, regardless of its size, seems to have no deterring effect upon demands for still greater compensation. In this issue reference is made to the payment of $135 to $154 to molders in a cylinder foundry for 12 days' pay. Here the practice has been so tremendously improved by the ingenuity of the management that a much bigger output is possible than when the piecework price originally was set, but which still remains unchanged. In this same shop, cleaning room labor is able to earn an average of $65 to $75 in two weeks. Similar conditions undoubtedly prevail in other casting plants, the minimum asked by organized labor having long since been forgotten. In another foundry where the sand is cut-over and tempered for the molders by a night gang, the day force recently refused to work one morning when the sand was not prepared, due to a break-down of the machine employed for this work. The fact that it is the general practice for the molders to pay for sand-cutting and tempering, when a machine is used, did not visibly affect this molding force. Incipient strikes are almost of daily occurrence and walk-outs are prevented only by yielding to the demands for higher wages or increased piecework prices. That the demand for the 8-hour day will become general, is conceded, and in another industry the men are preparing to ask for a 44-hour week. These demands will continue until the resistance point is reached. Apparently, there is no limit in the labor market and it will be tested to the point of fracture. These conditions, however, will prevail throughout this abnormal period. The pendulum is bound to swing to its highest point. Then the reflex action will set in. Whether it is more advisable to temper the backward movement by timely action at present is the problem. In some centers a few foundrymen have refused to yield to every demand that has been made. They are discounting the future, perhaps by several years, yet they are setting their house in order for whatever may transpire. It's an old saw, but an apt one—"a stitch in time saves nine."

Pig Iron Prices

In the leading producing and consuming centers, foundry grades of pig iron are quoted as follows: No. 2, Chicago, $19 to $19.50; Cleveland, $18.50 to $19; Pittsburgh, $19.45; Buffalo, $18.50 to $18.75; Philadelphia, $20 to $20.50, and Birmingham, $14.75 to $15. Malleable is quoted at $19.50, Chicago; $21.50 to $21.75, Philadelphia; $18.50 to $18.75, Buffalo, and $19.45 to $19.95, Pittsburgh. Lake Superior charcoal, Nos. 1 to 4, is held at $19.75 to $22.25, Chicago.

Personal

J. A. Lanigan has accepted a position as general superintendent of the plant operated by the Motor Casting Co., Detroit, manufacturer of cylinder castings.

John M. Perkins, formerly general sales manager and foundry superintendent of the Turner & Seymour Mfg. Co., Torrington, Conn., has been appointed works manager of the Gilbert & Barker Mfg. Co., Springfield, Mass.

Andrew Bryson, president of the Brylgon Steel Casting Co., New Castle, Del., has resigned and has severed his connection with that company.

Frank Krug, formerly representing the Joseph Dixon Crucible Co., Jersey City, N. J., with headquarters in Philadelphia, has been appointed sales manager of White Bros., Inc., ingot metal manufacturers, Philadelphia.

David Spence, a foundryman of wide experience, now is associated with the Adamson Vulcanizing Co., East Palestine, O. A plant is being built by this company for the manufacture of gray iron castings.

William A. Parent has resigned as general manager of the Edward Darby & Sons Co., Inc., Camden, N. J., and is associated in a similar capacity with the Dexter Metal Mfg. Co., of the same place, manufacturer of steel lockers, steel shelving, etc.

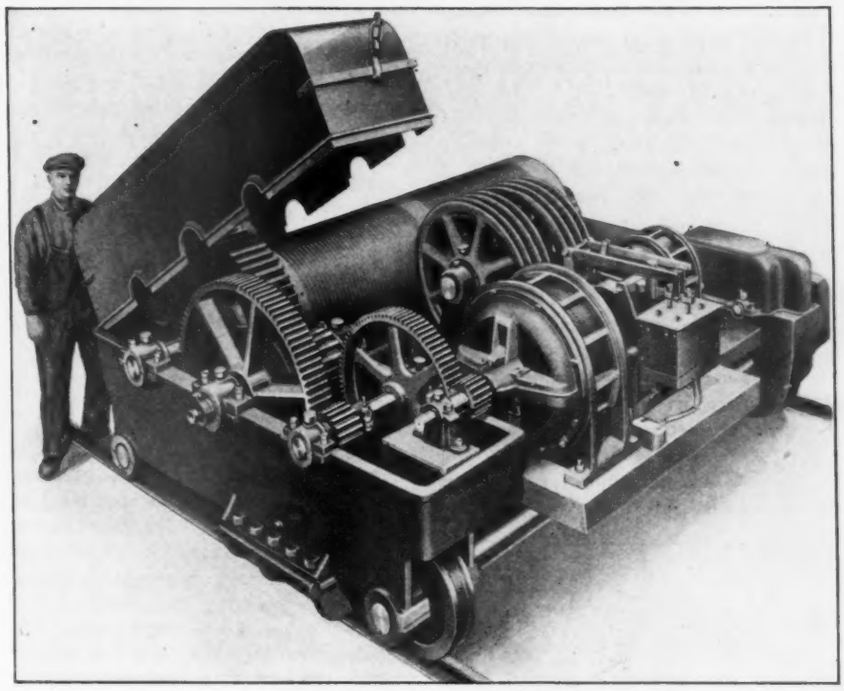
Lloyd E. Shirley, for a number of years superintendent of the C. S. Bell Co., Hillsboro, O., has resigned and is now associated with the Garland Mfg. Co., Des Plaines, Ill., in the capacity of general manager. He also was elected vice president of this company.

An Improved Power Squeezer

In the accompanying illustration is shown an improved type of power squeezer built by the J. F. Webb Mfg & Supply Co., Davenport, Ia. It is equipped with a new operating valve and is provided with an automatic shut-off valve which cuts off the air at any desired pressure required. The weight of the steel channels in the cross arms also has been reduced and the travel of the piston has been increased from 4 to 8 inches, thereby increasing the capacity of the machine. The wheels are provided with roller bearings.

IMPROVED POWER SQUEEZER BUILT BY THE J. F. WEBB MFG. & SUPPLY CO.

The Vitrified Wheel Co., Westfield, Mass., has practically doubled its capacity by an extensive addition to its drying room and by the erection of another story onto its main building.



TWO-MOTOR ELECTRIC CRANE TROLLEY, CAPACITY, 80 TONS, FURNISHED THE SEABOARD AIR LINE RAILWAY BY THE WHITING FOUNDRY EQUIPMENT CO.

A Large Locomotive Crane

The Whiting Foundry Equipment Co., Harvey, Ill., recently furnished a crane with a capacity of 160 tons to the Seaboard Air Line railway for its new shops at Portsmouth, Va. This is one of the largest alternating current cranes ever installed for handling locomotives. It is provided with two 80-ton trolleys, one of which is equipped with a 10-ton auxiliary hoist. The entire gear train is enclosed and operates in an oil bath. The motor pinion has an outboard bearing and the idler sheaves are mounted on a separator in place of being hung on, thereby permitting the operator to inspect the rope and oil sheaves while standing on top of the trolley; this arrangement also increases the lift of the crane 30 inches. The drum shaft is the only shaft which extends across the trolley. All the shafts in the gear train are on the same line and are cast steel, machine cut. The pinions are forged. The trolley sides and separator are made of cast steel, the housing is structural steel and is provided with hand holes for inspection and the easy removal of parts for making repairs. One of the 80-ton trolleys is shown in the accompanying illustration.

Fluorspar Breaks Record

All records for domestic output of fluorspar were broken in 1915 when 136,941 short tons were mined and marketed in the United States with a value of $764,475. The output in 1914 was only 95,116 tons. The average price per ton, fell from $5.99 in 1914 to $5.58 in 1915.

A Glove for Sand-Blasting

A new type of glove for sand-blasting work has been developed by the Hickory Steel-Grip Glove Co., Chicago. It is made of chrome tanned horsehide reinforced with strips of napa leather which are fastened to the horsehide with small steel ribbons clinched on the inside in a layer of canton flannel. The latter covers the sharp edges and prevents them from scratching the operator's hand. All the seams are stitched with fine steel wire and no cotton or linen thread is used on the wearing surface. The thumb is placed on the side seam so that the glove may be worn on either hand. This avoids the necessity of buying gloves by the pair. It is pointed out that wear on one

GLOVE FOR SAND-BLASTING

surface does not end the usefulness of the glove, as it may be worn on the other hand, bringing the unworn surface into play.

A heavy gauntlet protects the wrist. Extra reinforcement is provided at the thumb seam, which usually is a weak point. The steel wire stitching is said to prevent ripping.

Acid-Resisting Iron

Question:—We furnish cast iron pots to a manufacturer who uses them for boiling cyanide into which steel wrenches are dipped. These pots are subjected to a temperature of from 2,000 to 2,200 degrees Fahr. The life of the pots is about three days and while steel pots have been employed, their life does not compare favorably with that of cast iron. Is there any mixture which we can employ which would increase the life of these pots, and is there any wash or coating that would aid in strengthening these castings?

Answer: — A mixture which you might try consists of 1 to 2 per cent silicon, under 0.05 per cent sulphur, under 0.40 per cent phosphorus, 1.00 to 1.50 per cent manganese and total carbon low, about 3.00 to 3.50 per cent. No surface treatment will lengthen the life of these castings.

Book Review

The Metallography of Steel and Cast Iron, by Henry M. Howe, professor emeritus of metallurgy, Columbia University; 641 pages, 7 x 10½ inches, with numerous diagrams, illustrations, and 45 microphotographic plates; cloth; published by the McGraw-Hill Book Co. and furnished by *The Foundry* for $10 net.

It is difficult in the limits of a brief review to more than touch upon the many interesting features of this remarkable volume. Written by one of our most eminent metallurgists and representing the fruits of a long and active scientific career, the book may be said to embody the last word on the metallography of steel and cast iron. It is the first of a series of volumes in which the author expects to cover the metallurgy of steel thoroughly.

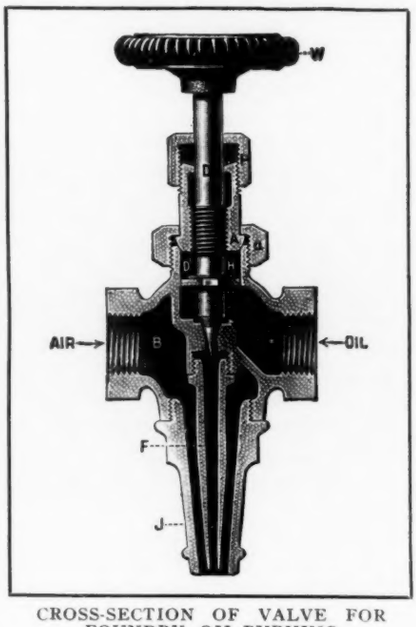
The volume consists of two distinct parts, an introduction to the new science of microscopic metallography as applied to steel and cast iron, and an extended study of a very new branch of that science, namely, the mechanism of plastic deformation. In the preface Dr. Howe points out that "the usefulness of steel really results from its resistance to deformation and its power to endure limited plastic deformation. Hence a knowledge of the mechanism of this deformation and of the way in which steel in part resists deformation and in part accommodates itself to it, may in time disclose the essence of its power of resistance and accommodation. To understand this essence is to be the better prepared to approach the problem of fitting the metal for service, not empirically alone, but also scientifically."

A considerable portion of the volume is devoted to the metallography of cast iron, because in the opinion of the author the study of metallography seems to hold out even greater promises to the iron founder than to the steelmaker. Dr. Howe states that he has strong reason to hope that the intelligent application of metallography may succeed in improving the properties of cast iron to such a degree as to broaden its application greatly.

One of the early chapters presents an exhaustive and complete discussion of the many mooted questions surrounding the classification and nomenclature of ferrous products.

Oil Burner Valve

A valve designed for the economical handling, regulating and burning of oil for foundry use, including its application to all types of furnaces and annealing ovens, has been designed and is being manufactured by the William Powell Co., Cincinnati. A sectional view of this valve is shown in the accompanying illustration. Oil and air are admitted to this valve from two control valves connected to either side. In the accompanying illustra-



CROSS-SECTION OF VALVE FOR FOUNDRY OIL-BURNING

tion, *D* is the machined stem provided with a needle point and a fine thread to permit of the close regulation of the oil; *A* is the bonnet with cone or beveled face connection similar to a ground joint union; *a* is the hexagonal union swivel nut which tightens the trimmings to the body, red lead or cement being unnecessary to insure making a tight fit; *B* is the body shell and illustrates the uniform distribution of metal, as well as the diaphragm thickness for a long, tapered bearing; *W* is the brass wire-bound non-heating hand wheel and *P* is the packing nut; *F* is the oil tube which has a long taper point adapted for close control and economical oil consumption, and *J* is the air nozzle. The valve is designed to withstand the rough usage to which valves of this type are subjected.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

Newton Kelsay, Evansville, Ind., will erect an addition to his foundry.

The At-Last Washer Co., Perry, Ia., will build a foundry addition, 23 x 65 feet.

The Lemoyne Brass Foundry, Lemoyne, Pa., is building a plant, 70 x 100 feet.

The A. B. Stove Co., Battle Creek, Mich., is building an addition to its foundry.

Leach Bros., 2926 First avenue, Seattle, Wash., will erect a foundry.

The Magee Furnace Co. is erecting an addition to its foundry at Taunton, Mass.

The Roeller Foundry Co., Bay City, Mich., contemplates erecting a plant.

The T. McAvity & Sons, St. John, N. B., Can., will erect an iron and brass foundry.

The Home Furnace Co., Holland, Mich., will build a plant, including a foundry, for the manufacture of heating furnaces.

The Oil City Brass Works, Beaumont, Tex., will build a brass foundry and machine shop.

The Corliss Gas Engine Co., Petaluma, Cal., will extend the Petaluma Foundry which it recently acquired.

The Union Foundry & Machine Co., Rockford, Ill., will build a two-story foundry addition.

Brown & Zimmerman, Neoga, Ill., are preparing plans for a stove foundry to cost $35,000.

The Titan Engine Co., Caper, Wyo., recently incorporated, will erect a foundry and machine shop.

The Columbus Malleable Iron Co., Columbus, O., is building a one-story plant of steel construction at a cost of $60,000.

A contract will be let for the erection of a 38 x 58-foot addition to the plant of the Louis Sacks Iron Foundry, Newark, N. J.

The Mountain Iron Foundry Co., Denver, Colo., will erect an addition to its foundry, 50 x 170 feet.

The Alma Standard Foundry Co., Alma, Mich., will move to St. Louis, Mich., where it will build a plant, 100 x 160 feet.

Bids are being received by the Strong Steel Co., Buffalo, for the erection of a two-story, 50 x 50-foot pattern shop addition.

The Hull Iron & Steel Foundries, Hull, Que., is erecting a 90 x 150-foot addition to its foundry at a cost of $30,000.

The Meekers Union Foundry Corp., Norwalk, Conn., will build a 35 x 100-foot addition.

H. S. Grey and J. N. Klock, Benton Harbor, Mich., contemplate erecting a steel foundry.

The Geneva Foundry & Machine Co., Geneva, Ill., is building an addition to its plant.

The Universal Plow Co., Florence, Ala., contemplates erecting a malleable iron foundry.

The Findeisen & Kropf Mfg. Co., 2100 South Rockwell street, Chicago, will erect a foundry, 25 x 110 feet.

The Galion Iron Works & Mfg. Co., Galion, O., is building another addition to its foundry, 68 x 100 feet.

The Canadian Car & Foundry Co., Kingsland, N. J., is erecting a brass foundry and eight other buildings.

The Louisville Foundry Co., recently incorporated, will erect a foundry at Louisville, O.

The Brennan Steel Casting Co., 2284 Scranton road, Cleveland, has changed its name to the Aetna Steel Castings Co.

William Marsh & Sons have opened a gray iron foundry in Port Hope, Ont., Can., and will conduct a jobbing business.

The Ohio Steel Foundry Co., Lima, O., has purchased the foundry of the Bucyrus Steel Castings Co., Bucyrus, O., which it will enlarge by the erection of additions.

Bids are being received by the Ansonia Chamber of Commerce, Ansonia, Conn., for a 60 x 100-foot foundry, which will be leased by Shortell Bros.

The Golden Foundry & Machine Co., Columbus, Ga., contemplates erecting an addition, the equipment for which has not yet been purchased.

W. E. Zahner, Kansas City, Mo., is building a brass foundry, 50 x 100 feet, which will be occupied by the Progressive Brass Mfg. Co.

The Lunkenheimer Co., Cincinnati, will build a foundry and pattern shop, the former one-story, 100 x 350 feet, and the latter four stories, 50 x 100 feet.

The Steel Foundry of Quebec, Ltd., Quebec, Can., has been incorporated with a capital stock of $49,000 by J. A. Larue, E. Massicotte and E. Trudel.

The Crown Pipe & Foundry Co., Jackson, O., is erecting an addition to its foundry, 90 x 150 feet and is extending its machine shop, 20 x 40 feet.

The Universal Foundry Co., Oshkosh, Wis., recently incorporated with $10,000 capital, will erect a 70 x 200-foot building to be equipped for a foundry and pattern shop.

The John Knapp & Sons Foundry Co., Akron, O., is enlarging its plant, having purchased the necessary Whiting equipment from the S. Obermayer Co., Chicago.

The Weeks Brass Foundry Co., Buffalo, has taken over the plant of the Farr Mfg. Co., North Tonawanda, N. Y., which will be equipped as a foundry.

The Fowler Machine Works, Ltd., Vancouver, B. C., Can., has been incorporated with a capital stock of $10,000 to engage in business as iron and brass founder.

The Popp Foundry Co., Rochester, N. Y., has been incorporated with a capital stock of $10,000 by Charles Popp, George T. Hoffman and Charles Stewart.

C. G. Chase has purchased the plant of the Special Machinery & Foundry Co., Indianapolis, with offices at Martinsville, Ind., and will continue the business.

The Sebring Foundry Co., Sebring, O., has been incorporated with $5,000 capital, by W. D. Young, C. E. Libert, A. G. Davis, E. G. Beighey and W. Hilliard.

The Somerville Iron Foundry Co., Somerville, Mass., has been incorporated with $50,000 capital, by Nathan H. Reed, Nathan P. Reed and M. D. Bingham.

The Benton Harbor Brass Foundry, Benton Harbor, Mich., has been incorporated with a capital stock of $5,000, by G. S. and H. S. Avery and J. Zeka.

The Toledo City Foundry Co., Toledo, O., has been incorporated with $10,000 capital, by J. C. Burt, J. and E. Holtzscheiter and A. and R. C. Burt.

The Philbrick-Booth Foundry Co., Hartford, Conn., has been incorporated with $20,000 capital, by Halsey B. Philbrick, H. R. Philbrick and Thomas T. Booth.

The Bay State Foundry Co., Westfield, Mass., has been incorporated by W. C. Waldron, Harry B. Putnam and Theodore C. Brien. The company has leased the plant of the Westfield Foundry & Valve Co.

The Hooven-Owens-Rentschler Co., Hamilton, O., contemplates doubling the capacity of its gray iron foundry by the addition of a new bay, which will be 70 feet wide and 400 feet long.

The Atlantic Foundry Co., Akron, O., practically double the capacity of its plant, the equipment for which already has been purchased from the S. Obermayer Co., Chicago.

The LaPorte Foundry & Furnace Co., LaPorte, Ind., has been incorporated with a capital stock of $50,000. The incorporators are G. W. Gilderman, W. N. Rumely, C. E. Wolfe and A. J. Hickey.

The West Newark Foundry & Furnace Co., Central City, O., has been incorporated with a capital stock of $25,000. The incorporators are C. W. Cunningham, C. E. McCracken, H. H. Shanck and N. E. Jones.

Joseph N. Smith & Co., Detroit, manufacturers of automobile hardware, will build a plant, including a main building, 120 x 313 feet, two stories; a foundry, 38 x 120 feet; a cleaning room, 24 x 60 feet and a power plant, 22 x 34 feet.

The American Locomotive Co., Schenectady, N. Y., will build a cylinder shop, 175 x 300 feet; an addition to the iron foundry, 100 x 175 feet; a two-story wing to the iron foundry, 55 x 230 feet and a paint and o. storehouse, 45 x 65 feet.

The Littlestown Hardware & Foundry Co., Littlestown, Pa., has been incorporated with $100,000 capital to engage in the manufacture of light castings. The incorporators are Luther D. Snyder, Emory H. Snyder and Sheldon K. Abel, all of Wrightville, Pa.

The Canada Stove & Foundry Co., Montreal, Que., has been incorporated to engage in the manufacture of stoves, machinery, implements, etc. The company is capitalized at $1,500,000, by Edgar R. Parkins, Ralph E. Allan, Frederick W. Tofield and others.

The Niagara Metal Works, Buffalo, N. Y., has been incorporated to engage in the manufacture of castings. It is capitalized at $10,000 and A. Weeks, O. J. Hudt and R. R. Parish, Rome, N. Y., are the incorporators.

The Brosche & Kenlay 20th Century Injector & Supply Co. is building a plant at Attica, Ind., which will be ready for operation in about 60 days. The company will manufacture brass, bronze and aluminum castings.

The Detroit Gray Iron Foundry Co., De-

troit, has been incorporated with a capital stock of $15,000. The officers are G. R Couls, president; Charles Erdman, vice president, and E. M. Couls, secretary and treasurer.

The Newark Stamping & Foundry Co., Newark, O., manufacturer of gas appliances, aluminum and gray iron castings, recently completed the second addition to its foundry, which has been made necessary by the consolidation of its business with that of the Moser Pattern Co.

The Wooster and Canton, O., plants of the Hinderer Bros., patternmakers and manufacturers of steam and hot water boilers, will consolidate under the firm name of the Canton Pattern & Foundry Co. The company will erect a foundry, one story, 60 x 85 feet, and a pattern shop and storage, two stories, 50 x 60 feet, both of brick and concrete construction.

The Fairbanks-Morse Co., Chicago, will erect additions to its Pelot, Wis., plant at a cost of $400,000 which will include the following: Central power plant, 90 x 274 feet; foundry office, chemical laboratoric pattern storage and millwright department, 70 x 177 feet; addition to the machine molding shop, 92 x 120 feet and an addition to the heavy molding foundry, 80 x 108 feet.

The Blackwood Steel Casting Co., Springfield, O., recently incorportaed with $450,000 capital, is erecting a foundry for the manufacture of small steel castings. A. F. S. Blackwood, formerly vice president of the Michigan Steel Castings Co., Detroit, is president and general manager. J. E. Galvin, vice president of the Ohio Steel Foundry Co., Lima, O., is also interested in the new concern.

The Pelton Steel Co., Chicago avenue and Elliott place, Milwaukee, has been incorporated with a capital stock of $100,000 by Fred Vogel Jr., William H. Schuchardt and Gustav A. Reuss and E. T. Pelton. Mr. Pelton, who formerly was associated with the National Steel Foundries Co., will be general manager. The company will make crucible castings until the electric furnace installation is made, which will be shortly.

The Bay City Foundry & Machine Co., Bay City, Mich., has been organized by G. Howlett, formerly general superintendent of the Industrial Works. He has been elected vice president and general manager of the new company which has taken over the business and plant of the M. Garland Co. John C. Ross has been elected president, W. W. Chapman, secretary, and Norris Wentworth, treasurer. A large amount of new equipment will be purchased.

The American Manganese Steel Co., Chicago, manufacturer of manganese steel castings, has purchased the plant of the Brylgon Steel Casting Co., New Castle, Del. This steel foundry has a monthly capacity of approximately 400 tons of steel castings. The American Manganese Steel Co. now has two plants at New Castle, Del., and one at Chicago Heights, Ill. The newly acquired plant will be converted into a manganese steel foundry, castings of this type to be manufactured there about July 15.

The Stowell Mfg. & Foundry Co., South Milwaukee, Wis., which was placed in the hands of a trustee on March 1, 1913, has been reorganized, the property having been taken over by a new corporation known as the Stowell Co. F. W. Rogers has been elected president; R. A. Nourse, vice president and general manager; T. E. Ward, treasurer, and Douglas Parmentier, secretary. The principal products of this company are malleable and gray iron castings, detachable sprocket chain, hay carriers, barn door hangers, malleable clevises and other wagon and carriage hardware, as well as automatic fire door fixtures.

NEW TRADE PUBLICATIONS

ELECTRIC GRINDERS. — An eight-page bulletin issued by the Chicago Pneumatic Tool Co., Chicago, is devoted to the extensive line of grinders manufactured by this company. These include portable surface tool post, pedestal, bench, precision, internal and external arbor grinders.

SAND MIXING MACHINES.—The Standard Sand & Machine Co., Cleveland, has issued a four-page folder which briefly describes and illustrates core and facing sand mixers and a facing mixer for steel and iron. Another booklet also is being distributed which contains a list of names of users of the machines built by this company.

PORTABLE ELECTRIC TOOLS.—A 20-page booklet, issued by the Stow Mfg. Co., Binghamton, N. Y., is devoted to its line of portable tools, including breast, two-spindle and universal drills, post and bench grinders, hand buffers, suspended direct-connected buffers and grinders, flexible grinder, flexible shaft drilling combination, flexible boring machine, suspended drill or grinder, portable emery grinders, etc.

GAS AND FUEL OIL ENGINES.—A 28-page catalog issued by the Chicago Pneumatic Tool Co., Chicago, is devoted to its line of gas and fuel oil engines. The bulletin is intended to give a general idea of the many applications made of these engines and to suggest to prospective purchasers how oil and gas may be used advantageously for operating generators, pumps, air compressors, blowers, etc., in direct-connected or belt-driven units. Numerous illustrations are included showing the various applications of these machines.

ELECTRICALLY-DRIVEN AIR COMPRESSORS.—A 40-page catalog issued by the Ingersoll-Rand Co., New York City, is devoted to direct-connected, electrically-driven air compressors. Among the principal features of design may be mentioned the Ingersoll-Rogler valve, the clearance controller, direct-connected drive, imported intercooler and auxiliary water separator. The catalog is well illustrated, showing construction details. Four pages are devoted to pressure charts and tables showing sizes and capacities. A bulletin containing 20 pages, issued by this company, describes duplex power-driven air compressors and the third bulletin is devoted to tie tamping outfits.

SAND-BLAST EQUIPMENT. — A catalog describing its comprehensive line of sand blast equipment has been issued by the Hoevel Mfg. Corporation, 50 Church street, New York City. This company has acquired the sole manufacturing rights for the Hoevel sand-blast machines, which formerly were imported from Europe. The catalog is exceedingly well illustrated and shows numerous sand-blast installations of the various types of machines built by this company. These include sand-blast machines with stationary nozzle, revolving barrel, rotary table sand-blasts of various types, sand-blast sprocket table machine, rotary table sand-blast machine, sand-blast chamber with turntable and sand blast chamber with rotary floor. The advantages of sand-blasted castings no longer need be pointed out to foundrymen.

GRAB BUCKETS.—A four-page bulletin issued by Edgar E. Brosius, Pittsburgh, is devoted to the various applications of the Brosius single hook grab bucket. In steel foundries they can be utilized for shaking-out sand, loading refuse into cars, cleaning up the molding floors, cutting and distributing the sand, filling molds, digging pits, etc. In gray iron foundries they can be used for similar purposes in addition to unloading coke, coal, sand, etc. At steel plants and rolling mills this type of bucket can be used to advantage for unloading and distributing gas producer and heating furnace coal, for handling coal in and out of stock, for removing roll scale from mill pits, for loading slag into cars, for excavating, loading dirt into cars and for unloading surfacing material from cars. Numerous service views showing this bucket in operation in various plants are included.

PYROMETRY.—The potentiometer system of pyrometry is described in a 28-page bulletin issued by the Leeds & Northrup Co., Philadelphia. This pyrometer is based on the use of the thermocouple, but differs from the ordinary deflection galvanometer or millivoltmeter pyrometer in that the electromotive force resulting from the difference in temperature between the hot and cold ends of the thermocouple is measured by a balancing method rather than by a deflecting galvanometer. A variable, but always known, electromotive force is connected into the circuit with voltage opposing that of the couple. A galvanometer also is introduced into the circuit, being employed to show when the two voltages are equal since at this time the pointer will stand motionless at zero. This method produces a pyrometer independent of the immersion and resistance of the thermocouple and of the temperature and length of the connecting leads and of the resistance and calibration of the galvanometer itself.

HIGH PRESSURE COVERING.—An 84-page catalog, published in textbook form and devoted to high pressure covering for high pressure and superheated steam lines, boilers, breechings, feed water heaters, tanks and heated surfaces, has been issued by the Armstrong Cork & Insulation Co., Pittsburgh. It is pointed out that while the necessity of installing heat insulation is generally recognized, the question of securing the insulating material best adapted to the severe conditions which now obtain has not been given the consideration it deserves. It is stated that it is not at all uncommon to find plants in which the boilers, stokers, superheaters, engines and turbines are provided with steam coverings entirely unsuited for the service encountered. Exhaustive tests both in the laboratory and under actual working conditions of the high pressure covering manufactured by the Armstrong company are reported in detail. At the Beaver Falls, Pa., plant of the Armstrong Cork & Insulation Co. a series of tests of this covering was made, as well as that of four other standard makes. The conditions under which these tests were made are fully described and the results are given in detail. As a result of these tests the heat losses from various sizes of pipe, both covered and uncovered, can be fixed definitely and these losses in B. T. U.'s per lineal foot, per degree difference in temperature for 24 hours also are tabulated. Tables are included which show in a general way the most economical thicknesses to use of the high pressure coverings made by the Armstrong company, which are based on different steam costs. A complete set of specifications for the correct installation of these various thicknesses of covering also are published.